TRANSACTIONS.

SESSION FIFTH, 1854-55.

TRANSACTIONS

OF THE

ARCHITECTURAL INSTITUTE

OF SCOTLAND.

SESSION FIFTH,

1854–55.

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CONTENTS OF PART I.

PAGE

INTRODUCTORY ADDRESS — By DAVID COUSIN, Esq., Architect, F.A.I.S.

I. On the Chemistry of Building Materials — By GEORGE WILSON, Esq., M.D., F.R.S.E. 1

II. Ditto, ditto (Second of Series). "On Siliceous Stones," 25

III. On the Formation of Provincial Museums and Collections of Works of Art — By CHARLES HEATH WILSON, Esq., A.R.S.A. 53

IV. On the Roads of the Romans — By ALEXANDER THOMSON, Esq. of Banchory 71

V. On the Present State of the Art of Design as connected with Science — By D. R. HAY, Esq., F.R.S.E. 107

VI. On the Chemistry of Building Materials — By GEORGE WILSON, Esq., M.D., F.R.S.E. (Third of Series). "On Calcareous Stones." 123

INTRODUCTORY ADDRESS.

Transactions of the Architectural Institute of Scotland,
Session 1854–55.

INTRODUCTORY ADDRESS.

BY

DAVID COUSIN, Esq., Architect, F.A.I.S.

(ABRIDGED).

[*Read at the Annual General Meeting of the Architectural Institute of Scotland, held on 30th November*, 1854.]

Gentlemen,

We are now met to open the Fifth Session of the Architectural Institute, and it must be matter of congratulation to all interested in its prosperity, to find that it has extended so widely in so short a period. It ranks among its members gentlemen from all parts of the country; and the list of new applicants for admission, embracing, as it does, many influential names of this city as well as of Glasgow and Aberdeen, affords solid testimony of its continued and advancing prosperity.

No one can read the Transactions of the last and previous Sessions, without being convinced of the great advantage of

such an Institute. The able papers in the volume recently issued are well fitted to raise the Society in the estimation of the public, conveying, as they do, information on matters of taste in a form calculated to interest and instruct a general as well as a practical reader.

Where all are good, it is perhaps unnecessary to allude to any one in particular. The paper, however, of Mr. Thomson of Banchory, on the subject of the Ancient Tombs of Rome, I may be allowed to select. It displays minute details of the manner in which that mighty people were wont to dispose of the remains of their dead, and cannot fail to prove most interesting and instructive to all classes of readers. The picture which Mr. Thomson brings so vividly before us of the long ranges of tombs stretching for many miles beyond the walls along the principal highways, emphatically tells of the smitten homes of that ancient people, and of their natural but vain attempts to supply the places of lost friends in their bereaved hearts. Were the fell bands of barbaric invasion to sweep over our country in successive floods, as they did over Rome, I fear we should have no such enduring monuments of family affection.

The care which that people bestowed on their dead, and their regulations with regard to burial, show a high state of civilization, and bespeak an appreciation of sanitary reform, which we, with all our boasted improvements, would do well to follow.

There is one subject which I cannot refrain from noticing for an instant, at this the opening meeting of the Institute. I refer to the Architectural Exhibition about to be opened in Glasgow, under the management of a body of gentlemen there, who have taken the responsibility of this great undertaking upon themselves. One can scarcely sufficiently admire the zeal for the advancement of art by which these gentlemen have been prompted; and from the spirited manner in which they have gone about it, there is every reason to augur the best success. There can be no doubt of the great benefit which must result to Architecture from this — what I take leave to call — magnificent undertaking. Without going further into details here, which will be brought before the public in another form, I beg leave very earnestly to express a hope, that every member of the Institute will lend a helping hand to promote its complete success, whether by contributing works of interest to the Exhibition, or by personally visiting the rooms, and recommending the Exhibition to the notice of his friends.

* * * * *

It may be, should demands continue to be made on the resources of our country, that the professional members may come to have more time on their hands than any of us care to have. But with such an Institute as that with which we are connected, no professional man has any excuse for being *idle*. It affords opportunities of bringing objects of

architectural interest before the public in a way which no private individual could command. There are a thousand fragments around us of the architecture of bygone days fast going to decay, all or any of which may be rescued from oblivion by members of the Institute. Almost every parish contains some such fragment—some picturesque bit, a door, or traceried window of our dilapidated ecclesiastical architecture—some turreted stair, Dormar window, or corbelled balcony of the dwellings of the sixteenth and seventeenth centuries, well worthy of being engraved in the Transactions of the Institute. A woodcut occupying half a page, occasionally devoted to these details, would give the public a taste for such subjects; and the preservation of such fragments for reference by the professional student would confer a great and immediate benefit upon art, and would render our volumes of Transactions of permanent interest. This is a means of advancing the art which no professional man has the shadow of excuse for neglecting. The opportunity meets him at every turn. The closes of our own High Street and Canongate (as of all our old cities), notwithstanding that the so-called improvements have, within the last quarter of a century, swept many of the finest specimens away, still abound in such objects of interest.

The peculiar mode of arrangement in the plan of the houses in our old closes, so as to secure what we here call "self-contained" houses, is a striking feature, which so far

as I am aware, has never been illustrated. The most casual observer must have noticed the unusual number of doors in these singularly picturesque old closes. This arises from the fact, that every floor formed a separate residence—a self-contained house, with its own door and staircase. Sometimes a more ambitious neighbour had an interior stair, by which he ascended to a part of the floor above. Often, too, the best houses were towards the top of the tenement, the humbler citizens occupying the more dingy apartments in the lower floors. These spacious mansions would sometimes spread over two or three of the houses of their neighbours below. Our forefathers, as compared with modern times, may have been content with very scanty accommodation, but they seemed to delight in the luxury of a "self-contained" house. Seldom, indeed, were two houses of any pretension to comfort found to enter by the same stair; a piece of refinement this which few would anticipate on looking down those dingy closes, half afraid to venture through them, now so associated with poverty and wretchedness.

The details of the interior of many of these dwellings are no less interesting than their peculiarly picturesque exterior, and many specimens of richly ornamented ceilings and carved wainscoting may still be found in these antiquated closes.

Mr. Billings has done much for the baronial mansions of Scotland; much remains to be done even here in the way of more practical details: but the work of illustrating the

less conspicuous dwellings of the sixteenth and early part of the seventeenth centuries has not even been entered on. It presents a large though rapidly lessening field, well worthy the attention of the members of the Institute.

While these suggestions are thrown out for the consideration of the younger members of the profession who may be supposed to have more leisure, there are other subjects of a more practical nature which the Council, looking to the usefulness of such an Institute, have had under their anxious consideration; and it has occurred to them, that no subject was more deserving of attention, and none more useful in a practical point of view, either to the members generally or to the profession, than a series of papers on the Chemistry of Building Materials. The Council felt that they had attained their object, when they had secured the valuable aid of Dr. George Wilson, who has agreed to read a series of papers on this subject during the ensuing Session. The peculiar qualifications of Dr. Wilson for this duty are too well known to admit of my saying a single word on this point, and I therefore beg leave to announce, that Dr. Wilson will now deliver the first of his series of papers on this very important subject.

ON THE CHEMISTRY

OF

BUILDING MATERIALS.

Transactions of the Architectural Institute of Scotland,
Session 1854–55.

No. I.

ON THE CHEMISTRY OF BUILDING MATERIALS.

BY

GEORGE WILSON, Esq., M.D., F.R.S.E.

[*Delivered at the Annual General Meeting of the Institute on 30th November,* 1854.]

You will remember, that when I agreed, at the request of the Council of the Institute, to read a series of papers on the subject of building materials, they willingly consented to the terms I proposed, that I should speak only as a chemist on the matter. I do not now, therefore, speak as an architect, as a builder, as a mineralogist, or as a geologist, but simply as looking at the subject from a chemist's point of view; and if I am in error in my views, or should I fail to state what is of service to you, we will not go beyond the first paper; for in this matter, as chemists do in all matters, I shall consider myself as simply making an experiment, in attempting to discuss the subject at all, and not in the least as coming before you in the character of one who professes to have made building materials very largely his study.

I suppose there are just six great building materials which mankind have used from the earliest times—namely, Wood, Earth, Snow, Stone, Iron, and Glass. The first three, wood,

earth, and snow, are especially the appliances of the savage or half-civilized man. Wood, as you all know, is used in the form of the wattled cabin, the kraal, the tabernacle of boughs, the shanty, the hut, and the log-house; earth appears in the forms of mud-cabin, turf-cabin, clay hut, sun-dried and kiln-burned brick dwellings; and snow, though *we* do not think much of it as a building material, is, in the Arctic regions, the only one serviceable for the Esquimaux; and our sailors, who have gone on expeditions of discovery, have thought themselves very comfortably housed when they had a series of snow walls around them. The second three, stone, iron, and glass, are the special appliances of the highly civilized man — stone, from the earliest historical periods; iron, very recently, but very extensively; and glass, not including its use for windows or hot-houses, most recently of all.

Of those six, wood may be regarded as the uniter of the savage and civilized builder, being as much employed now as it was in those days which Milton commemorates, when he tells us that Adam and Eve entertained an angel in their branch-built bower in the garden of Eden.

I shall only, in this paper, treat of stone; and it, as I said, I am to look at solely from a chemist's point of view; accordingly, as the shortest way of reaching important practical conclusions, I shall consider the question — What qualities are requisite in a good building stone? Asking that question, I have put down these six answers, namely —

1. A compact homogeneous structure.
2. Moderate hardness.
3. Insolubility in water.
4. Non-disintegration by the atmosphere.
5. An agreeable unchanging colour.
6. Non-liability to acquire a coating of vegetable matter.

As to the first of those qualities, it is scarcely necessary to dwell on the desirableness of a uniform and equable structure throughout the length, breadth, and thickness of a stone. All destructive agents — pressure, friction, air, water, frost, or vegetable growths — act unequally on heterogeneous masses. The vesicular lava, like this I show from Vesuvius, with a multitude of cavities in it, would plainly be unsuitable, other things being equal, as a building stone; as in these cavities dust would gather, then vegetable growths, and water would collect and begin to dissolve what was soluble, and the destructive gases in solution would wear down the stone. Even to this piece of vesicular and hollow lava there is the same objection, and the same objection also applies to such a rock as this piece of amygdaloidal trap which is to be found in our own neighbourhoods. The name of the last is from αμυγδαλος, the Greek name of the almond, from this dark whinstone having cavities in it filled with white bodies resembling almonds, like seed-cakes. This kind of stone is to be met with at Sampson's Ribs. The speckled surface shows the almond-like bodies on the one side, and on the other, you may see the cavities out of which these almond-like bodies, being more soluble than the rock itself, have dissolved. Granite rock, as you know very well, is found in such a condition that it may be polished, and preserved unaltered as regards appearance for a long time; still, from the fact that you have three different sets of crystals grouped together in the block, with interstices between the crystals, even where they touch each other most closely, it possesses a disadvantage as regards water, air, or vegetable growths, and is more liable to undergo change than a perfectly homogeneous substance. In like manner, in the sandstones before us, inequalities permit the same destructive agents to act. You are all familiar with those black lines

to be noticed in sandstones. These lines frequently result from layers of the body named mica; but in the sandstones of this neighbourhood, they are more frequently found of a charcoally or carbonaceous matter, resulting from the decay of such plants as the great tree discovered at Craigleith, or that at Granton, which have become fossil within the sandstone. Wherever you have an interruption of the continuity or to the homogeneousness of the stone, there you have a point of disadvantage. The French have a proverb that it is only the first step that costs trouble—*Ce n'est que le premier pas qui coute;* and here is the opportunity for the first step in this matter. Given the little point at which the apex of the wedge may enter, and the apex once in, the rest soon follows. There is no stone not liable to similar insecurity when we have any thing like inequality in structure. Few stones are more beautiful than shelly limestones—limestone like this, where you have a mass of calcareous matter with shells and corals embedded in it. Yet it needs but to look at its polished surface to see that the cohesiveness and hardness of the shell and its matrix are very unequal, and to perceive that the destroying and disintegrating agents are acting unequally on the surface, and must wear it down faster than they would a mass of statuary marble, all consisting of identical crystals, or a mass of pure sandstone. Even in those minerals which we are accustomed to regard as most solid, most homogeneous, and least liable to change, we very frequently—far oftener than we expect—find some heterogeneous element, often in very small quantities, yet quite enough, when acted on by disturbing agencies, to upset the equilibrium of all the remainder. Here is one of the most compact of known stones, quartz rock. This is a very beautiful specimen from India, and here is a specimen from Inverness of a kind more familiar to all of us. We know it

by the Scotch name of "chucky-stone," which some derive from the supposition that chickens prefer those little pebbles to others, and others from the game of chuck-farthing. Now, that beautiful white solid stone has, though the eye does not detect it, even within these layers, some portion of oxide of iron, one of the lower oxides (*i. e.* iron united with a little oxygen), that readily and gradually combines with more; and whenever a piece of rock containing small quantities of iron is exposed to the air, the iron begins to absorb this oxygen, to unite with it, and to increase in volume; and each little particle, acting like a wedge, splits the mass into fragments, or at least greatly lessens its compactness and cohesiveness. Even such stones as the agate, which we see cut into what we imagine to be a most enduring mass, are found to have long lines unequally coloured that admit of liquids penetrating them. Of that fact there is no doubt —indeed it is now turned to practical account by lapidaries, and agates are now artificially dyed, on a large scale, by immersing them in various liquids. These liquids are found to penetrate what was looked on as a mass of solid flint, and finding their way through invisible tubes, can be made, from colouring matter added to them, or by afterwards heating the stones, to communicate to them all kinds of tints. You will find in the jewellers' shops what they are pleased to call Russian agates, which are tinted in this way; and in the London Museum of Economic Geology, are blocks, showing the process carried through one part of the stone and not the other, and you can thus plainly see that these solids admit of penetration by liquids and of change. And here allow me to say, that in the reading of a paper like this, the great thing that hampers me is the want of specimens. That is one of the things that makes me additionally lament the death of my friend Edward Forbes, who would have seen to

the collection of such things. I refer to the matter to remind you, that though we are deeply interested in the war, and do not wish to divert public money from it for peaceful purposes, this Institute has a great interest in the Industrial Museum which is to be founded here; the money for it was voted last year, but we have not yet got the good of it. The Institute ought, I think, along with other public bodies, to see that the Museum is not forgotten in the war. Had it been in existence now, I should have had the pleasure of illustrating many doctrines, otherwise unintelligible, by the specimens I should have had to show you.

The second requisite I named was moderate hardness. All these texts for my prelections necessarily take the air of truisms. It seems almost needless to say, that a stone should not be too hard nor too soft; yet we know practically how much it means. Our builders have pitched upon the best name for indicating this when they use the word "freestone." In Scotland that name is almost solely applied to sandstones; but in England they apply it also to limestones, and simply mean by freestone, a stone that freely cuts and saws, and neither goes crumbling to powder, nor blunts the point of your chisel in working it, nor kills you by filling the lungs with sandy powder, as very hard stones do. Plainly, "moderate hardness" is a character of very great importance. Were mere compactness or hardness the only desideratum, then quartz rock would be preferable to all the stones we know, as we can get it beautifully equal, and approaching more nearly to uniformity of structure than any other rock, very little alterable by the air, and totally insoluble in water; but then it is so hard, that the cost and trouble, and time expended in the working of it, would be enormous, and the destruction of life would also be great. Even the stones we do use, such as granite, are many of them far too difficult

to work to be largely employed. I think the Institute saw the working of granite at Aberdeen, and they will therefore know, better than I do, what the difficulties of working it are. I had myself an account from Mr. Alan Stevenson, of the difficulties encountered in cutting the granite used in the building of the Skerryvore lighthouse; but it needs no proof to show, that these hard stones involve such time, and trouble, and cost, in working them, as greatly neutralize the advantages of fine polish, lastingness, and beauty. Even the sandstones are, some of them, too hard, especially our own beautiful Craigleith stone, which kills so many masons. I have it on what I believe is good authority, that even a softer stone — the Binny — used in the building of Sir Walter Scott's monument, has also been known to be very fatal to the masons working it. I am told, that during the building of that monument, which occupied four years, and employed seventy workmen, eighteen died by what they themselves call the mason's trouble. Notoriously, however, this Craigleith stone is the worst of all. The masons, themselves, if you talk to them, attribute the mischief to the sulphur in the stone. There is a little sulphuret of iron in the stone, and I fancy, that some of them having heard of this, ascribe the illness to it. But it is not the sulphur that does the mischief. It is merely the very fine irritating sandstone powder. The Craigleith stone, from its hardness, and its crystalline character, requires and admits of being chiselled down to a very fine powder, which is thrown into the lungs of the workmen, and there excites an irritation, which, if it does not end in consumption, ends in some disease as fatal. I shall have something to say on this subject again, when I come to speak of the different building stones in connection with the lives of the workmen; but it certainly is a sad thing to think, that Sir Walter Scott's monument is a

monument to eighteen workmen as well as to himself, and that as yet we do not know of any effieacious means of preventing sueh results, unless by driving away the fine sandstone powder, and by working the stone in the open air. I do not think that moustaehes are really of mueh avail. The notion arises from the German masons wearing beards; but I rather think that the Germans' exemption from the disease arises from their working in the open air, and from their working slowly—far more slowly than our masons do. I am told by the person who has the eharge of the heating of the stoves in the Outer Courts here, and who was foreman for some time when the Seott monument was building, that a man ean only ehisel six linear feet of Craigleith stone in the time he ean ehisel fifteen feet of Binny stone. If that statement be a true one, then the great hardness of the Craigleith stone is brought out in a way that requires nothing from me in referenee to the great differenee between the one kind of stone and the other. When a hard stone is ehiselled, all this fine powder is thrown about, mueh of whieh must find its way into the lungs of the hewers, where it eannot but do misehief. The only remedy, if our masons must work under sheds, would be some eontrivanee for blowing away the dust, as they have in the Manehester eotton-mills, where what they eall the fluff is blown away; but you always find the workmen themselves the least willing in sueh things; for it is well known, that many of the eotton-spinners refuse to work with these fluffers, beeause they say it makes them hungrier and eosts them more to buy their dinners—And what ean we do in sueh a ease?

To eome to the third point, it seems at first sight very needless to say, that a stone should not be soluble in water, as if any one would propose to use stones that were. But you must remember, that there are stones used in other

countries which are soluble in water, and which are suitable for dry climates, though useless with us — such as alabaster, called also sulphate of lime, and gypsum. The stones which Mr. Layard found at Nineveh consist of alabaster or gypsum, which is soluble in water; and although one ounce of water will only dissolve one grain of these; still the maxim holds true, "the drop wears the stone." It may not suddenly wash away a house; but plainly, for architectural purposes, any stone soluble in water, so that the beautiful lines of carving will suffer by every shower that falls, is not to be thought of in a country like this. What is the use of alabaster columns, or palaces of marble in this climate? The solubility of their material in water is one reason why we should never have Buckingham arches, or other marble buildings, in this country. If you have a statue like Scott's, it must be under cover; and even Scott's statue, where it is, will suffer; for marble, which is carbonate of lime, is soluble in water. It is soluble to a small extent unquestionably; but if the water contains carbonic acid — and all rain does contain carbonic acid — then it dissolves marble more readily, and it should not be used in a climate like this, where all exposed marble statues, pillars, or carvings, are infallibly rounded in the outline by every shower. For exterior ornament our sandstone is infinitely preferable. But when I speak of solubility in water, it is not with the purpose of merely alluding to alabaster or marble. I would direct your attention to this very important fact, that with exceedingly few exceptions, all building stones contain something soluble in water, and that if water once begins to dissolve the stone, the integrity of the block is invaded, and sooner or later it crumbles. We are not in the habit of thinking of granite as having much to do with solution in water. We make great fountain basins of granite in such a crystalline condition as

resists the action of water for ages; but there are other granites, not distinguishable by the eye, or chemically, from those enduring ones which rapidly crumble, as you may see from some specimens here, which have been exposed to the action of water; and they crumble because one of the constituents of granite — the one which gives it its colour, viz. — felspar, which is red in this and white in that block, is the alkali potash or soda, united with silicic acid. These alkalis are readily soluble in water. They are kept from dissolving if firmly united with a certain amount of silica, as they are in glass, but in certain conditions, very obscure, the power of solution is recovered by the alkali, and the rain acting on the granite, begins quickly to dissolve the alkali and the felspar gives way; the black mica and the glass-like particles of quartz are separated, and the whole mass breaks down. I am anxious to impress on all, that in the selection of a building stone, apart from its not being in mass, or altogether soluble in water, we must keep in mind to what extent it contains a single thing soluble in water. Our own whinstones and trap rocks are in the same predicament as granite. These are familiar stones in this neighbourhood. Here is a green stone porphyry from Arthur Seat, here is a compact block of basalt from the same, and here is another piece of trap from that hill—all to a certain extent soluble in water. Certain of these specimens of whinstone, not only as we find them at Sampson's Ribs but elsewhere, are at all times slowly changing under the action of the weather, while we see in Egypt basaltic columns remaining for unnumbered centuries without change. Here they alter rapidly, as every stone that contains alkalis does; and you may pick from Arthur Seat, as I have had occasion incidentally to notice, weathered pieces of greenstone like this, and even of basalt, which, when you drop acid upon them, effervesce powerfully. They have been

so altered, that they contain alkalis united with carbonic acid, though no carbonic acid is found in them if you take a piece with a fresh surface. Sandstone is one of the very few building stones which are quite insoluble in water, and that is one of the many excellences it possesses as a building material. It is not itself in mass soluble in water, and frequently it contains not one per cent. of soluble matter in it; so that, though it absorbs water, it does not crumble in the way that harder rocks, such as granite and whinstone, very readily do.

I now come to the fourth point, "non-disintegration by the atmosphere." That after all is the most important point the chemist has to deal with. There is no stone—absolutely none—quite indifferent to the action of the air, and which does not undergo some change of the nature of a destructive one. I may point, however, to one seeming exception, an exception proving the rule; namely, a very remarkable building stone from India, called *laterite*, from the Latin name for a brick. It is found on the west coast of India, south of Bombay, down to the very point of the peninsula, and also in Ceylon and in the Malayan peninsula. It occurs partly in cliffs rising high up on the sea-coast, and partly forms superficial masses over great districts which are wholly unfertile. It has this remarkable peculiarity, that when you dig it, it is soft, while at the outer surface, if it has been exposed, it is a hard stone like this. If you remove the hard external coating, then you come to a mass as soft, in some portions, as cheese, as I have been told by Lieutenant Aytoun, of the Bombay Artillery, who has kindly sent this specimen. Other portions, not so soft, can be cut with the spade, so that they shape it into blocks of almost any size. Then it rapidly hardens like Roman cement, and becomes this massive stone. The old Inquisition at Goa, and the old Portuguese Cathedral, as well as the old Pirate Forts which abound along this coast,

are constructed of latcrite ; and indeed it is uscd in India in prefcrence to any other building stone, where it can be had. It results from the decay of granite, or syenite rock like granite, and a rock vcry rich in felspar, and containing much iron. When I come to spcak of mortar, I shall recall your attention to this stone as presenting us with a great deposit of what may be called nativc Roman cement, which may be dug soft, and then hardens itself into the hardest mass. We have no such stone in this country. The stones found in most parts of thc world rapidly give way under the atmosphere. It would be difficult to enumerate all the ways in which atmosphcric agencies affect building stones. Excluding electrical discharges, I will notice — 1st, Alterations in temperature, causing unequal expansion and contraction — stoncs irregular in structure, and conducting heat unequally, being liable to be split, from one portion expanding more than the othcr. 2d, The absorption of water by the pores present in thc most solid stones, followed by the freezing of the water. Watcr, in freezing, as we all know, forms crystals of ice, occupying a much largcr spacc than thc liquid water did, and thus it may split thc stones to fragments. I need not enlarge on the manner in which water acts destructively, coming from the atmosphere. Water finding its way into the most porous stones, as indicated under the previous hcad, vcry scldom fails to find something it can dissolve ; and dissolving that, it lcssens thc compactness and cohesion of the stone. The truth is, that the more wc look into the matter, the more we find, that with the exception of the metals — such bodies as charcoal, sulphur, and a vcry few othcrs —there is scarcely a chemical compound not soluble in watcr. I do not think a chcmist would like to say, that any body was insoluble ; but there are multitudcs of bodies which we arc in the habit of putting down as insoluble—meaning

by that, that they are so slightly soluble, that for practical purposes, whether in reference to pure water, or in using chemical tests, we can disregard their solubility, though they are nevertheless so soluble in water, that in the course of years the action of that liquid upon them affects them, and ultimately causes very extensive changes in the condition of the mass. We shall come to practical instances of that by and by; I merely state the general fact. 3d, More important than any of these is the direct corroding action of active chemical substances. They are not very numerous, and their action on the whole is very simple. The most important of them, probably, is carbonic acid. We always have carbonic acid in air, and can detect its presence by putting out a little lime water in an open vessel. All burning, all the respiration of animals, all decay of vegetable matter, and all furnaces pouring forth gases into the atmosphere, as well as many mineral springs, are continually adding carbonic acid to the air; and although we have a wonderful agency for diminishing it, in its consumption by plants during sunlight, still there is a surplus over, and that surplus is constantly corroding all our buildings. Carbonic acid does not act so much as a gas as when dissolved in rain water. Rain water, with carbonic acid added to it, has the power of dissolving, for example — marble, carbonate of lime, and phosphate of lime. It can also dissolve carbonate of magnesia, present in certain limestones, such as the Bolsover limestone employed in the building of the Houses of Parliament — a stone containing magnesia and lime united with carbonic acid. This stone is not soluble in water alone, but is distinctly soluble in water containing carbonic acid. This carbonic acid acts with great energy on such stones as granite, in certain conditions; but we do not understand as yet, otherwise than imperfectly, why it is, that of masses of granite, one will remain unacted on by atmospheric agencies

for an indefinite period, whilst another will go crumbling down, and in the course of a few weeks, will often be reduced to a state of utter disintegration. Here are specimens illustrating the decay of granite. In granite you have three constituents; the one glass-like crystals of quartz. These crystals are like hard brilliant transparent obelisks. They may be coloured like the Cairngorm or Amethyst, which are yellow, brown, or purple crystals of quartz that have shot up from a mass of granite or similar rock. Then you have always a black looking body, called mica, the nature of which we shall see by and by. It is not altered by the air. In addition, you have a third constituent, that gives the white, flesh, or red colour to granite, namely felspar. It has either potash or soda in it. It is on that potash or soda, in certain granites, that the carbonic acid of the air, dissolved by rain water, acts so injuriously. The acid begins to extract alkali from the felspar, and the felspar crumbles down ultimately into a white clay — a process continually carried on, and assisted artificially in Cornwall and Devonshire, with a view to obtain clay for the potteries. Here is the first stage of decay in a piece of granite so acted on. We have still the crystals of quartz unchanged, and in some places you can see the crystals of felspar. The crystals of felspar are in some parts little changed, but all over the mass you have a white powder, which consists of those portions of the felspar which have crumbled down. Felspar may be regarded as white pipe clay, or the whitest China clay, united with soda or potash. As soon as the rain water dissolves the alkali, then the felspar is changed into white clay, and separates from it. This represents the first stage. Here is a piece representing the second, in which you may see the decay proceeding. In the third—though these stages are only arbitrarily distinguished—the whole has got into a

chalky mass, with brilliant shining particles. In that state it goes by the name of Cornish stone, from its being used in this state in the potteries. Here is the fourth stage, in which you find a mealy powder coming from the granite, much like white China clay powder. The preparers of the clay at the potteries direct a stream of water on the face of the granite rocks, and by this process continually wash away the clay, the mica, and the quartz. The water, with the clay suspended in it, is allowed to run along a channel. The heavier quartz and mica soon fall, and the clay is carried further on, and ultimately deposited in a pool from which the water may be drawn off, and the whole allowed to consolidate, until it becomes like bricks, in which state it comes to market. This is the condition of granite which the Germans call diseased granite. It is perhaps the best example that can be given of the remarkable power of one of the atmospheric agents — carbonic acid dissolved in rain-water — in breaking down the hardest stones.

The second great disintegrating agent is oxygen. To make this part of the subject clear, we should need a lecture on the atmosphere; but I fear I can only name oxygen at present. This oxygen is continually acting on many of the ingredients of our stones, continually wearing those down, and in many cases, changing them to metallic oxides and then to salts. Every one of those massive pieces of whinstone, if looked at through the microscope, shows dull black grains of metallic iron. They are disseminated through the whole mass, and when exposed to the air, they rust, as iron of any other kind will do; in rusting, they get a brown colour, which a piece of exposed trap or whinstone sooner or later in most cases acquires; and as each little particle of iron becomes changed, and the little fragments or particles of oxide of iron occupy a larger space

than the iron did before, they swell out the adjoining portions of the stone, crack it, and mechanically alter it. Moreover, this oxide of iron is readily washed away, and leaves a cavity, in which water can dissolve what is soluble in the mass. The most remarkable example of atmospheric agency, where oxygen is the cause of change, is presented by what we call iron pyrites — a source of great trouble to builders. Iron pyrites are composed of sulphuret of iron, and occur in two quite unlike shapes. Here is a specimen of one of them — what we call slate diamond. It appears in brassy cubical crystals — the beautiful surface remaining, in roofing slates, for an indefinite period unchanged. Iron pyrites also occur in a different crystalline form, which, so soon as exposed to the air, begin to absorb oxygen. The iron turns to oxide of iron, and the sulphur to sulphuric acid; these yield sulphuric acid and green sulphate of iron — a substance quite soluble in water, and which by and by, from the further absorption of oxygen, changes to a brown body. This body is the great cause of the spotting of many sandstones. We have in them sulphuret of iron deep down. That sulphuret has a colour like brass; but when you bring the sandstone to the surface, and allow air to enter the pores, the sulphuret of iron begins to oxidise into sulphate of iron. It is brought to the surface by water, is changed to oxide of iron, and there is no cure for the mischief. Then sulphuret of iron not only stains the stones, but of course splits them up. It does not occur largely in any of our stones; but I refer to it in illustration of oxidation as altering the composition of the mass. Alum-slate, which contains pyrites, looks, when dug up, like a book bound and half compressed together; but after you expose it to the air for some time, it opens out like a fan, or as if the paper leaves of the book had had a multitude of little wedges

put in, and the whole expanded. The action of oxygen in this way is extremely powerful, so that it must be regarded as one of the destructive agents that must be kept specially in view in selecting stones.

The other atmospheric agencies are more obscure in their action, and I shall only name them. They are—nitric acid, developed in the atmosphere by every lightning flash, and found in rain water; ammonia; and a curious body named ozone, an agent rivalling chlorine in its singular effects on other bodies, and which, there can be no question, must act even more energetically than oxygen, on such bodies as it encounters. We may add to these sulphurous acid, as the coals we burn, and even the coal gas we burn, is always yielding a certain portion of sulphurous acid. It has been ascertained in the town of Manchester, that rain water contains sulphurous acid, a weaker acid than sulphuric acid, but changing, by exposure to the air, even into the latter. Now, as both are certainly destructive agents, and are brought down by every shower on the roofs of our houses, and thus are liable to run over the surface of our buildings, we must keep them in view, and record the action of sulphuric acid when enumerating the chemical agents in the atmosphere destructive of building materials. The whole of these agents are much more efficacious when combined with rain or water than when dry. We all know that in the climate of Egypt, the ancient temples remain scarcely changed; and as they are built of sandstone, granite or syenite, basalt, limestone (of which the pyramids are built), and other materials, it is impossible to attribute their durability to the mere quality of the stone. On the painted walls of Egyptian buildings, even vegetable and animal colouring matters remain nearly as bright as they showed three thousand years ago—a permanence not attributable to the ingenuity of the Egyptians

in selecting enduring substances. It is owing to the dryness of their climate that their buildings have so long subsisted; and this is a remarkable example of the different principles on which a builder, in a climate like this, should proceed, from those on which a builder might act in Egypt, where rain seldom occurs.

Fifth, as to pleasing colour, I need not say much about it. Merely for utilitarian ends we do not require the colour of a stone to be thought of; but this Society is largely æsthetical as well as practical, and will therefore, I presume, look on colour as a very important element in the execution of their designs. For example, whinstone is almost too dark to be welcome in a climate so sombre as this. Many of our red sandstones are also, to my eye, very disagreeable. They are of an uncertain dull red, some very dark, and none of them coming up to the colour of red brick. Our red trap is something the same. Among sandstones and limestones we have a choice of pleasing colours. The Craigleith stone is white, but not so pleasing as the fuller-tinted Redhall or the Binny. I like the buff colour of the stone used in the Houses of Parliament. A buff, a brownish-yellow, or a pinkish-yellow, are the colours most generally liked—I infer as much at least from the fact, that it is to such tints, especially to the two first-named, that the term stone-colour is generally applied.

Sixth, The last requisite I have to refer to, is, non-liability to acquire a vegetable coating. No property in stone has been less examined than this. My friend, Dr. Balfour, tells me, that botanists have scarcely yet looked into the question. He is to furnish me with specimens to illustrate the nature of plants clinging to stones, for a subsequent paper. I have not a great deal to say regarding it. There are two modes familiar to us all, in which stone acquires a coating of vege-

table matter. One is, where the stone is continually wetted, and displays a bright green streak, such as we see in numbers of our buildings, that streak being occasioned by plants, of the order *confervæ*, clinging closely to the stone, and giving it an unpleasing colour. The other coating of stones is, where there is little moisture accompanying the development of vegetable growths. There it is mainly in the form of lichens. I do not know æsthetically any coating of stone which is less to be objected to; indeed some regard it as a beauty; but looking at it from a chemical point of view, we object to the lichen. That there is a very marked difference between the tendency of different stones to become coated with vegetable matter, all must have noticed. I saw this strikingly illustrated some years ago, when not anticipating saying a word on the subject here, in the stones of Stonehenge. That great mysterious circle of stones, which I suppose we may say is at least two thousand years old, as the Romans wondered at it as a strange thing when they saw it, consists in the large external range of sandstone, much like some of the whitest of those we have here, and it is only slightly spotted with lichens. I have since seen in Bute, drystone dikes of limestone, probably not two hundred years old, and there not only were the whole stones spotted over with lichens, but even the gaps between the stones had been filled up with a rich vegetation. When the stone gathers much moss, that moss begins to crumble into a mould, in which plants of a higher character than lichens grow, so injurious, that botanists give them the name of *saxifrages* or stone-breakers. These follow the growth of the original lichen on the stone. In Bute also I saw drystone dikes of trap rock, probably not older than those I have referred to, totally uncovered with vegetation, the bare stones lying on each other with not a growth upon them. In towns the accumulation of vegetable matter

in buildings is less than in the country. They are less subject to those *confervoid* streaks, and the conditions of a town atmosphere are all less favourable to the growth of plants. There is therefore always less of it in towns than in the country, though it does occur in the former to some extent. This important point is to be recollected in connection with the growth of plants on stones, more in reference to the selection of rocks in quarrying, than to the injury which the stone suffers from being spotted with pleasing-coloured lichens. Stones which in the quarry, or elsewhere, readily acquire a coat of vegetation, and stones that crumble quickly into arable soil, are less suitable for building purposes than those which do not. A stone which quickly becomes a *nidus*, or nest of vegetation, must be one which is porous, absorbent of water, possessed of ingredients soluble in that liquid, and readily susceptible of disintegration by the atmosphere. As we know, the lavas of Vesuvius and Ætna crumble down to the richest soils, and we know that our own green stone of Corstorphine also readily crumbles down to rich soil. The very coarse limestones, which contain magnesia, potash, soda, and phosphate of lime, likewise crumble down to good soil, and plants readily grow on them. I think I can venture to assert with great confidence, that where in a quarry there are different kinds of stone, that one should be chosen which spots least with vegetable matter, and makes the worst soil when disintegrated, in preference to that which makes the best. It is the saving of building stones, in relation to plants, if nothing will grow *on* them. Buildings, however, are also injured, when the seeds of plants are carried up by birds and by winds into the crevices of stones and grow there. We see ash trees growing in this way, from their winged seeds being carried into the spaces between the stones. There are such trees on the road to Liberton, and there are one or two on the road

leading past the Zoological Gardens, and I remember one also at Dirleton Castle. In India there is a well-known tree, called the *peepul (ficus religiosa)*, resembling the banyan, which is considered as sacred by the people. The seed of it grows in the crevices between stones; the inhabitants will not meddle with the tree; and I am told by an Indian officer (Lieutenant Aytoun), that there are cities, now in ruins, where the singular power of this tree to overturn architecture, is shown in a remarkable way. In Beejapore, an ancient Mahometan town, now in the possession of the British, the engineers had a world of trouble in removing these trees. In some instances, where the seed had lodged itself high up, the root evidently pushed itself down, like the air plants which may be seen in the Botanic Gardens, and then put a rootlet into the next crevice or joint in the wall, and so descended, till finally the root struck into the earth, and you might see whole walls broken down by the wedge-like roots expanding, and also masses of masonry carried up with it by the tree as it grew. This point, however, belongs rather to the consideration of mortar; for the seeds rather grow in the crevices between the stones of the wall than in the stone itself. It is, however, a curious point in reference to architecture and the durability of materials.

To recapitulate, then, a building stone should be compact, moderately hard, little liable to solution in water, little liable to decomposition by the atmosphere, little disposed to alter in colour, and not prone to acquire quickly a vegetable coating. Now, to secure these conditions, certain mechanical as well as certain chemical qualities are requisite. That certain mechanical qualities are essential, as well as certain chemical ones, is manifest from this, that two mineral masses may have the same chemical composition, and yet be very unequally acted on by the same agents. I gave you an example of

that already, in iron pyrites, where we have one kind of it in one crystalline form, which remains unacted on, and will not dissolve in acids, neither in sulphuric acid nor nitric acid, and that does not become dimmed or tarnished after any length of time; while we have it in another crystalline form, which, as soon as it is brought into the air, changes to green sulphate of iron, and rapidly dissolves. In the same way, at Dartmoor, there is granite which they work for building purposes, and send to London, where it is now coming seriously to interfere with the sale of Peterhead red granite and Aberdeen grey granite, and which appears to be unalterable; while, at the same place, other masses of granite are found rapidly crumbling down by the action of the air, although not chemically different from the kind which does not so crumble down. In the same way the Bolsover magnesian limestone, which was selected for the Houses of Parliament from amongst an immense number of stones, as the best stone for building purposes, is assuredly not much acted on by atmospheric agencies, while other magnesian limestones go with great rapidity — the carbonate of lime dissolving out of them and leaving the carbonate of magnesia. Some of those magnesian stones consist of multitudes of little grains, like the roe of a fish, cemented together; but they present a great diversity of surface to chemical agencies, downward from such magnesian limestones as our lithographers use, which are generally pretty nearly homogeneous in structure, and admitting of fine polish. Certain basalts, also, crumble with rapidity into fertile soil, whilst others are not acted on by the chemical agents in our laboratories, even with the assistance of heat, though we expose them to the fire for a very long time. The causes of these differences are obscure, and I will not at present stop to discuss them. I will be better able to take up the question of how far mechanical

structure affects the integrity of stone as distinguished from chemical composition, as we review the great building stones. I will therefore say but one word at present on the chemical properties of stone. The chemical properties are dependant chiefly on eight substances. Of these eight, six are metallic oxides — *i. e.* compounds of metals and oxygen, and they are what the chemists call bases. These six bases may be arranged in three sets or pairs. In the first place, there is a pair of calcareous earths, the one is lime, the other magnesia. This pair of bases largely occurs in building stones. The second pair may be familiarly called clay earth and iron earth. Clay earth is what the chemists call alumina, a soft white powder, forming a large part of clay. The sapphire is crystallized alumina, with a blue tinge; the ruby is crystallized alumina, with a red tinge. We may either give it the English name of clay earth, or the chemical name alumina. Iron-earth, the other one of this pair, is oxide of iron. The third pair are the alkalis, potash, and soda. You have thus six metallic oxides, which may be remembered as arranged in three pairs. Then there are two acids; carbonic acid, occurring so largely in limestones, and silicic acid or silica, forming the entire mass of pure quartz, and constituting from 98 to 100 per cent. of sandstone. In arranging building stones for practical purposes, we may divide them into two great groups, the one named from the bases, the other from the acids. The group named from the bases is the calcareous group, and we may more familiarly call it limestones. The second is named silicious, from silicic acid, which is a white powder like alumina, but with very different properties. The silicious group is represented by sandstones. Under the head calcareous, we include marble, all forms of ordinary limestone, and magnesian limestones. Under the head silicious, we have a much greater number — for example,

quartz, flints, sandstones, granite (including syenite), the whole of our whinstones, the whole of our roofing slates and slate stones, with a few others of less importance. I will take up the subject of silicious and calcareous stones in my next paper.

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ON THE CHEMISTRY OF BUILDING MATERIALS.

BY

GEORGE WILSON, Esq., M.D., F.R.S.E.

SECOND OF SERIES.

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In the paper which, at your request, I had, on a former occasion, the honour of reading to this Society, I offered some general remarks on the chemical qualities desirable in building stones, and made general allusion to the chemical substances most largely occurring in them, and affecting their characters as constituents of their structures. At the close of the paper, I came to the conclusion, that building materials, so far as stone is concerned, might be advantageously arranged under the two great heads of silicious stones and calcareous stones — sandstone being our most familiar example of those which are silicious, and limestone of those which are calcareous. I am this evening to take up the consideration specially of the silicious stones, leaving the calcareous to be discussed in the next paper, along

with lime and mortar, with which they naturally connect themselves. Silicious stones are by far the most important in Scotland, and nowhere more so than in Edinburgh. The word "silicious," which gives its title to this large class of bodies, is derived, as doubtless many of you know, from the Latin word "*silex*," meaning flint, and from its genitive *silicis*, we have the word silicious, the purport of that word being, that all stones termed silicious have in them about half of their weight of the same substance as ordinary flint, which, when pure, is named Silica. Sandstones are practically nothing but silica. Craigleith sandstone, for instance, contains as much as 98 per cent. of silicious earth or flinty matter. Some rocks, such as Serpentine, have not more than about 42 per cent. of silica; but, on the whole, I may say, that the silicious building stones contain from 50 to 98 per cent. of silica, and that those which are in use in this country—namely, sandstone with 98, and granite with 74·84—consist more of silica than of any thing else. What the old Romans called *silex*, the modern chemist thus calls silica and also silicic acid, for though it is not sour to the taste, it has the powers and properties of an acid. The chemist prepares it in the state of an exceedingly fine white powder, as I have it here, and in that condition it does not dissolve in water or melt by ordinary heat, and is not affected by any of the common acids; it is, in fact, one of the most enduring and least alterable substances known to us. Yet we can procure it in as soft, pulpy, and gelatinous a form as in this specimen, in which you could not tell it from ordinary boiled starch in the condition in which the laundress uses it; and we find, that artificially, we can crystallize it. In nature we obtain it in the form of regular geometrical figures, having always either the same shape or shapes, limited within a certain series. In crystals it always holds, that the smaller

are the most perfect. In this little jar I have four perfect crystals of silica, the forms of which cannot be seen at a distance, but if looked at near, they will be seen to be shapes resembling this model, which represents what crystallographers term a six-sided prism; in other words, a column of any length which has six faces, the top of each column or crystal showing a hexagonal plane exactly like the top of the six-sided honeycomb cell of the bee. Such six-sided prisms may exist entire, but are often broken. Here is a six-sided prism, colourless, forming what we are accustomed familiarly to call rock crystal, which is terminated at one end by a six-sided pyramid. This pyramid is produced by a triangular plane or face being carried up from each of the faces of the column, till all the planes, sloping towards one another, meet in a point. This will be seen in the rock crystals here, where we have at one end such a six-sided pyramid terminating a six-sided prism; but these crystals sometimes show not only a six-sided pyramid at one end but at both. They consist of such a column as this, terminating at either extremity in the six-sided pyramid referred to. Such crystals are, however, very rare, as the majority of silicious crystalline forms have shot up out of the rock, which is their matrix, and are embedded at one extremity in it. The large crystals are specially irregular. Here is a large one, a Cairngorm crystal—our Cairngorm ornaments being cut out of such quartz, coloured either yellow or brown, from the presence of small quantities of iron, or vegetable or animal matter. Here one does not at first see distinctly that there are six faces, yet on coming to count them, he finds that the faces, though not equal in size, are six in number. The same remark applies to the crystals in this specimen, which are found shooting up like obelisks or spires.

The substance, then, termed flint or silex, or silica or silicic acid, or rock crystal, is the main constituent of the building stones we are to look at this evening, and in fact, is the main constituent of the great masses of rocks occurring over the surface of the globe. There are just two great masses of mineral matter forming rocks, the one lime, the other silica, and it is to the silicious descriptions of rock we are now to look.

Now, so far as we are interested in silicious stones in Edinburgh, it is sandstone which most concerns us; but as the sandstones are all geologically derived from other rocks, and have their building qualities affected by the character of the rocks they are derived from, it will be convenient, though I am not to discuss these qualities as a geologist, rather to begin with granite than with sandstone.

Granite, which is a rock more or less familiar to us all, derives its name from the Latin word *granum*, a grain, so that the word literally means grainstone—in other words, a granular rock, a rock made up of separate grains, sufficiently large and unlike each other to be distinguished by the naked eye. In this drawer are a series of granites, the majority of them being used for paving stones in Liverpool, London, and elsewhere. The smaller-grained ones, those where the crystals are the smallest, illustrate best the granular character of the stone, especially if we look at it on the unpolished side. If any here are unfamiliar with the appearance of granite, they have only to look at these specimens, to see that they justify the term granular. One sees in them, even at a distance, a series of unlike grains, in appearance altogether different from those seen in white marble, where, with the exception of the spots or veins, every particular grain is like every other, whereas here there is uniformly an intermixture of differently coloured and differently sized particles. Such a granite as

this, which is familiar to us as the Peterhead granite, illustrates the point well, though perhaps the grains are rather larger than in the majority of granites used for building purposes. Now the grains making up granite are always crystalline; that is to say, they are not rounded in form, but, like the crystals which I referred to previously, they have planes or flat faces, and sharply-defined angles or corners. In those granites where the particles are small, these grains appear embedded or wedged together like so many paving stones in the street. They appear as if they had been all crushed or wedged, or rammed together, so as to fit tightly, and do not permit one readily to see what the particular configuration of each single grain is. But in favourable circumstances, we see granite permit each one of its constituents to lose this irregular and squeezed condition, and to shoot up into separate crystals, each crystal projecting from the under mass, as church spires or obelisks do from the general outline of a city, and being unlike the others in shape, colour, and size.

Allow me, then, very briefly to state what these constituents are, as they are each of importance in reference to the durability and beauty of granite as a building stone.

The first constituent, then, is quartz, rock crystal, or silica. These great crystals, some of which are many feet in length, and from a single one of which as much as £400 worth of jewellery has been cut in Edinburgh (in the case of the Cairngorm, the crystals are a little paler in tint than those I now show); these crystals are one of the three components of granite, which, instead of remaining wedged in among the others, has shot up in separate spires or distinct crystalline columns. Here is a mass of granite, showing each of the constituents crystallizing out of it—these dark bodies being the first component I have to speak

of, silica, which, though so dark as to appear opaque, contains little more than a mere trace of colouring matter. I have some specimens here from Ireland of crystallized granite, which, if looked at near, you will find to show each one of its three components in a distinctly crystalline form.

In regard to colour, rock crystal or silica may be termed colourless. The very word "rock crystal" is intended to signify something occurring in rocks as colourless as the purest glass; and large quantities of silica are found native, totally devoid of any tint. It is often also grey, or yellow, or amber, as in our most prized Cairngorms, also dark brown and black, as in this large crystal, and purple and blue as in the amethyst. So far as shape is concerned, it is in the six-sided column already referred to. As for size, you may have it from minute grains up to crystals some feet in length.

This quartz is one of the silicious components of granite, but silica occurs again in the other two crystalline bodies making up the mass.

The second of these bodies is named *mica*, from the Latin word to shine—this substance having a glistening appearance. Here is a large plate of it, for the loan of which, as well as for other specimens on the table, I am indebted to the kindness of Mr. Alexander Bryson. This plate illustrates strikingly the appropriateness of the term. Every one will be struck with the brilliant appearance of the surface of the mass, which appears brown or nearly black by reflected light. It is however transparent, and used to be employed instead of glass for the panes of windows. It is still employed in India and in Russia for the windows of stables and for lanterns, being less easily broken than glass. You will notice, that at the edges it spontaneously splits into a number of films or layers like so many thin sheets of paper;

and we find that this characteristic of mica gives a peculiar character to the sandstone derived from granite, or other rocks containing this body. The mica is the constituent in the granite, which occasions the black spots appearing through it. In every specimen of granite, whatever be its prevailing character, those black spots occur, and it is they which mainly produce the mottled or granular appearance, and enable the eye to detect readily the want of homogeneous structure. Occasionally the dark spots are owing to dark quartz, but not generally.

The third constituent of granite is called felspar, from a German word literally signifying field-spar, or a spar occurring largely in the fields or open country — a shining opaque spar. Its colour varies. It is sometimes white; more frequently of a flesh, or grey, or cream colour, and occasionally of deep red. Specimens of Labrador felspar show a very beautiful iridescent appearance, or a peculiar play of colours like the wings of a pigeon, or the feathers of a peacock. This felspar is a very abundant mineral, and forms a large part of all granite as well as of other rocks.

Granite then is a granular rock or grainstone, with three kinds of crystalline grains, one set being of silica or rock crystal, which are often perfectly colourless like glass, the second set being of shining glistening mica, and the third set being grains of felspar, glassy-like, but opaque, and generally whitish or flesh-coloured, so as to resemble a glassy marble.

Now as to the relative significance to builders of these bodies, which of the three is the most important in reference to the qualities of granite as a building stone? Without doubt, the most important is the felspar. In the first place, it mainly determines the colour of the granite.

In this drawer will be seen granites of various tints, some having a grey colour, approaching to white, many having a duskier or darker grey, some having a very deep grey, many with a brownish or buff colour, some of a bluish or flesh colour. Here is a deeper flesh colour in the well-known Peterhead granite; and in the Oriental granites we have a full red colour. Now the colour of granite is mainly determined by the felspar, and next by the mica, which, if very dark, comes to affect the shade of the felspar. But of more importancc than as affecting the colour, is the relation of the felspar to the durability of the stone. The condition of the felspar mainly determines whether the granite shall maintain its proverbial character of being the most lasting of stones, or whether it shall be one of those which most easily give way. Felspar is always the first ingredient in granite to yield, if the granite undergoes marked disintegration or decay. As I mentioned in last paper, felspar contains two alkalis, potash and soda. These are soluble in rain water, and many specimens of felspar, though when one looks on them they seem to form a solid, enduring, stony mass, very rapidly give way when exposed to the air, and come indeed by so crumbling to be thc source of a substance of great value, namely the fine clay used in the making of porcelain. But, of course, to convert building stones into porcelain clay, however valuable that may be, is not a matter which the architect desires to accomplish. Accordingly, in selecting granites, one needs to be very careful in watching the condition of the felspar; for the more glassy and brilliant it appears, and the less earthy its appearance, the more enduring is it likely to be. It is not desirable, moreover, in selecting a granite for building purposes, where one knows nothing of its history and of its trial in actual buildings, to selcct one where the quantity

of felspar is very large. The Scotch granites are proverbially lasting, and no one of them is very rich in large crystals of felspar. The Cornish granites, on the other hand, have large crystals of felspar in them, and that felspar has not a glassy, but an earthy look; and many of them may be made in a few weeks or months to crumble into a white mass, and then permit the mica and quartz to separate from the felspar, and thus the whole undergoes complete destruction. Occasionally, however, granites are found with large crystals of all the three kinds. The pedestals of the statues of George IV. and Pitt, in this town, consist of granite with such crystals. One cannot pass them without seeing the crystals of felspar, which greatly mark the surface, but do not decay. This, however, is, as it were, a perfect granite on a large scale — everything is big; but where the mica and quartz are small, and the felspar crystals are large, and are at the same time rough or soft, then the granite is suspicious, and is to be distrusted.

The least important of the constituents, in a building point of view, is the mica. It is the least abundant constituent of granite. It does not readily decay, but it will split into scales if long acted upon; but it is not readily affected by rain or wind, and is not soluble in water.

The quartz or silica may be put in the middle, between the mica and the felspar, as an index to the building value of the granite. It is the hardest constituent, and is that which makes it difficult to hew. It should always, however, be abundant; for if granite be troublesome to cut, it compensates for that by its lastingness. The value of this lastingness is to a great extent to be measured by the difficulty in polishing, hewing, or otherwise fashioning the stone.

So far as regards the localities of granite in this country, I need scarcely mention them further than to say, that

the Grampians consist largely of granite; that in Cumberland, Devonshire, and Cornwall, we have it abundantly; and that in Ireland it is found in large quantity in the county of Wicklow. For paving purposes — a use to which it is not much applied in Scotland, where it is generally objected to on the score of its becoming slippery, though in London, Liverpool, and elsewhere, it is largely used in that way — the Cornish or Devonshire granites, which are not so hard as the Scotch granites, are held to be better, as you do not require for paving the most enduring granite, nor is there any architectural beauty to sacrifice in the choice of a paving stone. It is not like the case of a splendid erection, in which the smallest deteriorating influence is something to be lamented, and for paving you do not require a very hard stone: indeed, the harder granites certainly become too slippery. For building purposes, with the partial exception of the Dartmoor granite, the grey Aberdeen granite, and the red Peterhead granite, stand above all others in this country. A special value attaches to the granite of Mount Edgecumbe, Cornwall, which has felspar, with nearly as deep a red as in the Oriental granite, and for its beauty is now selected for a few purposes; but it is not largely used, so far as I know, any where.

There is a kind of granite called Syenite, which I merely name. It may be called a large grained granite. It receives its name from a district in Upper Egypt, where large quantities of it occur. Some of the most beautiful Egyptian statues are cut out of it. Syenite does not differ markedly from granite in constitution, except that it has no mica in its chemical constitution, but another mineral like it, which is called "hornblende."

It will be observed, that in mica there is a very large amount of silica, as well as in felspar, so that if we were to

put down the silica separately, in each of the crystalline components it would occur three times over. That 74·84 which is put down in this table for the amount of silica in granite, represents the silica of rock crystal, the silica of mica, and the silica of felspar.

Alumina, the next important component of granite, is what I mentioned in my last Paper as clay earth. It occurs almost entirely in the felspar; oxide of iron also occurring sometimes in small quantity in the darker rock crystals and giving them a tint. To mica it gives its brown tint, and to felspar its flesh or red colour. Lime, magnesia, and potash, occur alike in the felspar and the mica, but not in the quartz.

I now pass from granite to other silicious building stones —and first of the sandstones. They are for us by far the most important of silicious stones. They are, in a chemical point of view, most interesting, as they contain the largest amount of silica of any stones. They are geologically derived from other rocks, as, for example, granite; and their characters vary according to the rocks they are derived from. I do not propose to trace minutely their derivation. That must be left to the teacher of geology, as doubtless you will hereafter have the geological relations of building stones brought before you. I will notice, however, that as silica is the most abundant constituent of all rocky masses, and as it is a body very little alterable, it may separate from any one of those rocks, and come ultimately to form a sandstone. Putting aside limestones and calcareous rocks, the characteristic ingredients of which are lime or magnesia, or both, you will find that the trap-rocks, basalts, greenstones, the whole of our slates, syenite, gneiss, serpentine, and many others, contain more of silica than of any thing else. They are all liable to be worn down to powder by the action of rain, wind, and water, and the silica thus worn out of them

is not a thing alterable in itself, and may be deposited and re-formed into a stone. Sandstone may thus be derived from a great number of rocks, unlike in kind, and the qualities of the sandstone will correspondingly vary. If we take, for example, whinstone, a name we apply to what geologists term greenstone, such as the whinstone of Arthur Seat or of Corstorphine, which we mainly use in mending roads, we shall find that a very large portion of that stone is silica, as we have seen that a still larger portion of granite is silica. Now, if whinstone be reduced to fine powder by the action of the water of rivers, or of the currents or tides of seas, we may ultimately have the silica separated from the other components of the stone, and converted, by a method to be presently more particularly referred to, into a solid mass of sandstone. Sandstones so produced are to be found all the world over, differing in character according to their derivation from one kind of rock or from another. Allow me very briefly to illustrate this, as it is really of importance in relation to building stones. If I were to reduce one of these granites or whinstones to fine powder, and then throw the powder into a large vessel containing water, stir it there rapidly, allow it to stand, and in a short while pour off the water, and along with it the finer powder, I should be able in this way to separate the lighter from the heavier particles, and ultimately I should find left the heaviest portion, namely, the silica or sand, as a sediment at the bottom, which might be dried up into a substance resembling an unconcreted or unconsolidated sandstone. What I do on a small scale, when I stir the powdered rock with water, and then pour off the water, rivers and seas have been doing since the beginning to rocks on a very large scale, and in a much more effectual way. Suppose, then, what we can see any day in our Highland hills, that we have the granite

or greenstone undergoing disintegration, whether by the action of the water or the air, and that the fragments are borne down, and fall into the bed of the stream. They are carried along, rubbing against each other, and in fact grinding each other, so that all angularity of shape disappears. The separated crystals, for example, as in the case of granite, which once showed a six-sided pyramid or prism, become very soon rounded pebbles; and then the pebbles, rubbing against each other, are ground to still finer powder, and this carried down into lakes or the sea, is ultimately spread out in a stratum on the bottom of the body of water. Still more, as we can observe any day at Newhaven, the waves dashing on the rocks close to the shore, break down fragments from them, and rub these fragments against each other, and when they are brought back by the tide, they are never sharp or angular, but always rounded pebbles, and some of them so round, that you would imagine they had been cast in a mould. This rubbing, moreover, reduces much of the fragments made to undergo friction against each other to fine sand, so that there is nothing we so much expect to see along the shores of a lake or river as this sand. Altogether, when we look at the effect of water in wearing down and grinding against each other masses of stone, we find that there are three sets of things encountered in river beds, on the shores of lakes, and on the beaches of seas, namely, *first*, pebbles or gravel, always rounded, however sharp or crystalline they may have been at first; *secondly*, mud, that is to say, a fine soft powder, diffused like boiled starch in water; and *thirdly*, sand in fineness intermediate between the pebbles and the mud, and forming a hard powder. Now each one of these three deposits may become altered in structure, by allowing it simply to remain at rest at the bottom, covered

over by successive sediments deposited above it, and ultimately it may become changed by the lapse of time, by pressure, by heat, and by other causes, into a solid mass of stone. The pebbles or gravel, for example, become agglutinated, or cemented, or concreted, by clay, or lime, or iron, or all the three, into a mass we call conglomerate or pudding-stone. Here is a polished pudding-stone or conglomerate, where one can see distinctly pebbles quite unlike the matrix, and a cementing mass causing them to cohere together. But this is not a thing we need to make a matter of trust. Here is a piece of the rock called Laterite, which is formed not at the bottom of the sea, but at the very surface of the earth in India, where it may be daily witnessed concreting and forming out of irregular pebbles or masses, resulting from the disintegration of granite or greenstone, and other stones very rich in felspar. These stones, in virtue of the abundance of iron, and of clay and lime in them, after they crumble, curiously enough immediately reverse the process of crumbling, and cohere into a solid, though heterogeneous mass, as hard as building stones. But we are more familiar with these changes, as happening at the bottom of lakes or the sea, after a long time, and with a great pressure upon the sediments there. Here are masses formed of mud, baked as clay in the bottom of a lake or sea, and hardened into slates or flag-stones. Mr. Bryson has kindly sent these large slabs or flags, which are brought from the Welsh quarries, and consist of what was in fact originally the mud of ground-down older rocks: that mud has first solidified at the bottom of a great sea of water, and the solid mass, by the action of great pressure, heat, and other causes, has been, as it were, baked into these hard solid paving stones. Here we have several similar stones on a smaller scale. This one, which, by its shining

lustre, shows that it mainly consists of mica, and is what we call a micacious schist or slate; and here are ordinary roofing slates, which are the consolidated mud of ground-down rocks, at one time soft like clay baked in the sun, but ultimately becoming as hard as the hardest stones, though still keeping their peculiar foliated structure. Further, as the pebbles and the mud may thus concrete into these pudding-stones and slates, so the sand may concrete into sandstone. Now as we have two great classes of original rocks, which are worn down into mud, or pebbles, or sand, there are two classes of derived rocks from them, the one derived from calcareous rocks, and like them calcareous, the other derived from siliceous rocks, and like them silicious. If we go to the sea-shore in some districts, we shall find a shell sand — a sand consisting altogether, or nearly altogether, of broken-down shells, and a very fine mud, consisting of ground-down shells; and again we find, that sand or mud cohering together into a solid mass, very like these slates or these paving-stones. But these are never called sandstones. They are all, whatever be their structure, or appearance, or real or conceived origin, named limestones; and therefore I say nothing more of them at present. By the word sandstone, we understand not only in Scotland but elsewhere, a body derived from the wearing down of siliceous rocks, such as granite or greenstone, and which consist in great part of silica, or of silica alone.

So far as our Scotch sandstones are concerned, the most of them are wonderfully pure. Those suitable for building purposes contain very little foreign matter, and some of them have been derived from the disintegration of granite, but certainly others have not been so derived.

Let me notice what they contain in addition to silica. We have sandstone in all degrees of fineness. Here is a

stone which quarriers know by the familiar name of Grit: it is employed for millstones. The particles are large and crystalline, and there are little spaces between them, so that the whole has very much the appearance of a mass of white sugar, but with the crystals or single grains larger. There is reason to think, that in our own neighbourhood there are some building sandstones of this character. The late Professor Edward Forbes mentioned more than once to me and to others, his having noticed, soon after coming here last summer, stones forming the gate posts of some building near Musselburgh, consisting of regular crystals of silica. I did not learn from him the precise locality, and we all know how these inquiries were prematurely ended; but I mention the matter here, that I may direct the attention of architects to these gate posts, which I understand are to be found somewhere on the Musselburgh road. The stones of these posts must have been brought from some quarry in the neighbourhood, which may be found out on inquiry.

As no sandstone probably has been derived from the mere wearing down of a mass of silica, but all of them from the wearing down of rocks like granite, having other things in them besides silica, we may expect them all more or less to contain foreign matters. Thus most of our sandstones contain some mica. You may see it very fine in this sandstone, giving it its glossiness — the shining micacious glistening appearance we have here. These glistening particles, however, are not desirable. They tend, like so many wedges, to split up the stone. They are deposited between one quantity of sand-powder that has been laid down, and another coming above it, and therefore disturb the continuity of the mass. The less mica, then, the better. This mica, moreover, as it contains in itself a portion of lime and of

alumina, may transfer these to the sandstone; and when you come to look at the recorded analyses of sandstone, some of them are found to contain sensible quantities of lime and of alumina, which interrupt the solidity, the continuity, and the homogeneousness of the stone, and lessen its building value. Then, as I noticed in the Craigleith stone, we may have a fine black matter in these stones. When sand has been carried down a river, on the banks of which plants grow, and are blown over into the stream, where they float down till they become water-logged and sink, there we very often have vegetable matter interspersed through the stone, as the great fossil tree in Craigleith shows. Here is a small fossil plant in illustration. If one looks at the broken section, it appears a mass of sandstone. It is nothing more than a cast of the plant; but we find there is enough of vegetable matter remaining to give it this carbonaceous coating. These carbonaceous layers are to be found in more or less quantity in many sandstones. All those non-silicious substances interfere with the continuity, solidity, and tenacity of the stone, so that the less of them the better. Not only plants, but also animals, especially shell-fish, are found in the neighbourhood of these sandstones, or actually embedded in them, and from these animal and plant remains, bituminous matters are frequently transferred to the sandstones. The Binny sandstone has bitumen interspersed through it in very small quantity; if you take a fragment of the stone and heat it at a candle or lamp, a black fiery matter will be found to ooze out in little globules. This bituminous matter probably does no harm to the stone; I rather suppose, that like varnish, it protects it from the action of the atmosphere; at all events, it is a peculiarity in this stone as compared with other stones used in Edinburgh, and may be connected with the

peculiar changes in colour which it undergoes when exposed to the open air.

Lastly, I may refer to the occurrence in sandstones of sulphuret of iron, the cause generally of the unpleasant spots which appear in them. Here is one specimen, which has accidentally come into my possession, exactly illustrating that point. It is from the sandstone of Hailes Quarry, and occurred in brilliant little crystals, so beautiful, that a quarryman set it aside for a lady curious in collecting specimens. He put it in a piece of paper, but coming in a few days to open it, found it had become this dark-looking body; and if any one is curious enough to taste it, he will find it to possess a strong taste of ink. It was found at first in a condition quite insoluble and tasteless, and consisted of sulphur and iron; it has now changed into what we ordinarily call copperas, *i. e.*, sulphuric acid and oxide of iron. This sulphate of oxide of iron is readily formed in sandstone containing the sulphuret, when the stone is brought to the surface. The air penetrates through the pores of the sandstone, and effects the change which has occurred in this specimen. When rain-water brings the sulphate to the surface, then what was originally a green spot soon changes to a dark brown one; in fact, to what we have here, brown oxide of iron, or iron rust. I do not know which of the Edinburgh sandstones are most disposed to spot, but a public building which I frequently pass, the Rev. C. J. Brown's church, is a sad example of the lessening of the beauty of the stones by the occurrence of this sulphuret in them. They are built in, seemingly free from all colour, and exposed to the air; then the change occurs, and ugly brown stains show themselves.

The less of all such things the better. The mica makes the stone more easily split, the clay destroys its tenacity

and homogeneousness, the vegetable matter irregularly blackens it, the iron pyrites stain it after exposure to the air, and if there be soluble substances, as potash, these promote vegetable growths; therefore, the more uniform, crystalline, hard, granular, and unmarked by dark spots, or glistening particles, or iron pyrites, a stone is, the better fitted is it, in the estimation of a chemist, for building with. We may take our own Craigleith stone as, confessedly, one of the most admirable sandstones in the world. It has the highest place in the well-known report given in by Professors Wheatstone and Daniell of London, on the stones most suitable for the Houses of Parliament. I select it, as confessedly a stone of great value and of good report. It contains 98 per cent. of silica, the remainder being lime, water, and other matters not accounted for. Allow me to read what they say, for the sake of one remark desirable to be made upon it — "The component parts of the Craigleith stone are fine quartz grains, with *a silicious cement*, slightly calcareous, and occasional plates of mica." It is, no doubt, made up of very fine grains of quartz, meaning by that, very fine grains of silica; it is slightly calcareous, for it has about one per cent. of lime, and there are a few plates of mica. They say, however, that the fine quartz grains have a silicious cement. Now, I wish to make a remark on the subject of cement. A notion seems to prevail among builders and architects, which is largely warranted by the style adopted by writers on the subject, that stones like sandstone, known to have been produced by particles originally derived from older rocks, have some cement uniting together the little grains, and converting them into one mass. Now, no doubt, we have rocks thus cemented, as we see in these pudding-stones, and this brick-stone or laterite, and as we shall afterwards see

when we come to mortars. Unquestionably there are certain bodies, such as lime, clay, and oxide of iron, more or less present in even those stones or rocks which we speak of, as if entirely consisting of something else, and these substances have a remarkable cementing power. But certainly the notion of the need of cement has been carried much too far, for what is it that cements together the particles of cement? Is there some cement within cement, and some cement again within that? There was a similar notion in Sir Isaac Newton's time in reference to chemical combinations, and it was a puzzle to know how an acid could combine with an alkali. An ingenious man said, that the acid possessed sharp particles, and the alkali blunt ones, and that they fitted in to each other; in short, that it was like a set of hooks and eyes, which, coming together, caught each other. Some one asked what the hooks were made of, and whether the hooks consisted of little hooks and eyes, and the eyes of little eyes and hooks, and if all these little hooks and eyes were made of lesser eyes and hooks—and so on, till, like the problem of the divisibility of matter, it was found that you must go on multiplying your hooks and eyes till the whole theory becomes a fiction. In like manner, this idea of a necessary cement is one which has too much prevailed among writers on architecture, Professors Daniell and Wheatstone leading the van in the matter. I do not pretend to say, that there are not cementing bodies distinct from the other components of a stone in many cases, but I think it a matter of great importance to say, that there is no need for supposing that such cements always occur. The most homogeneous rocks which the chemist or natural philosopher would prefer for building stones, are those which are least likely to have, and in which one would least desire to have, any such cementing matter. There is no point on which we can more

confidently speak than this, that the particles of a powder will of themselves, without any cement of any kind, by mere pressure, and still better if, in addition to pressure, you supply heat, aggregate into a solid mass. In illustration, I may refer to the conversion of snow into a glacier. You have great masses of fallen snow consisting of a multitude of little crystalline grains, just as sandstone consists of crystalline grains; that snow, when it begins to move slowly down a slope, and descends in the form of a glacier or frozen river, changes into solid ice, of ice where all the crystalline particles have aggregated into one clear glassy mass; and if we have not seen glaciers, we have seen what illustrates the point quite as well, namely, boys making a slide. When there is a heap of snow on the pavement, and the sliders run their feet over it once or twice, one sees the mass of snow become clear and glassy, so that he may even look through it to the stone pavement some inches down. It is true, that the objection may be made, that there is a plasticity in snow favouring the union of its particles. But let us take blacklead powder. Probably most artists are aware, that their blacklead pencils are now no longer cut out of blocks of native blacklead plumbago, these blocks having become exceedingly scarce and very costly. Instead of using this, coarse blacklead is taken, ground to very fine powder, rammed into a mould without any gum or cementing material, and merely subjected to a strong pressure: it comes out a solid mass, which can be cut into pencils like the native block. In the same way clay powder is now compressed into tiles for tesselated pavements; in the same way we can consolidate silica powder. Here is a portion of silica in the condition of a light impalpable powder, as fine as the finest starch powder; it is not the least gritty, and will blow about like dust. Now take this powder without pressure at all, and expose it

in the bowl of a tobacco pipe, or in a crucible for a couple of hours to a red heat, and the particles will come out hard, heavy, and crystalline. There is no reason, therefore, why we should insist on cement occurring in sandstone; and when those reporters state, that the fine quartz grains in the Craigleith stone have a silicious cement, they are only saying that silica is cemented by silica; *i. e.*, that a thing is cemented by itself. The truth is, that the best sandstones are those which simply have their particles compressed together closely, even though the particles are pretty large, as in this specimen, which we may call a grit, and where they only touch each other at certain points. Once brought close together by mere compression, they adhere with a tenacity which the most powerful force can hardly overcome. We can imitate that result with the polished surface of glass. In our laboratories we may find, that if the stoppers of bottles are too nicely ground, and fit the neck of the bottle too neatly, they cannot, when once put in, be got out. You may make the same experiment by putting two panes of glass together, and firmly clamping them once, after which they will not come asunder; but, as has been found in the polishing of plate glass, they so cohere that you may saw them at right angles to their surfaces, and even polish their edges without separating them. I wish, therefore, that the notion of cement were laid aside, and that the builder would see that the less of foreign matter, the greater the solidity, the tenacity, and the enduringness of a stone.

As far as regards sandstones, they are almost devoid of soluble matter. The Craigleith sandstone, for instance, has 98 per cent. of silica, and is so free from substances undergoing alteration by the air, that I do not know that any one can be held to be superior. The great objections to them are the difficulty of hewing them, and the injury to

the workmen's health in chiselling them—this injury mainly occurring from the fact, that the very fine powder into which the sandstones chisel, is alike irritating and irremovable. Chemists like myself, are largely exposed to irritating agents, such as gases, acid vapours, and fumes of various kinds; but though their action is a very marked one, and chemists may suffer from affections of the lungs in consequence, still these vapours are sooner or later absorbed in the system, if their action is survived; but if the fine powder of silica dust once enter the lungs, it remains there like a foreign matter—like the fine steel dust from which the Sheffield knife-grinders and sword and razor sharpers suffer; continually exciting inflammation, irritation, cough, and ultimately consumption; and it is so notorious to hear of masons perishing early, who are solely employed in hewing, that I found one of them not apparently able to conceive of a mason surviving his wife. He spoke as if every one must of necessity leave a widow, and as if the notion of the husband living the longest was not to be thought of. The Rev. Dr. Nisbet lately devised a horn respirator, manufactured by Messrs. Blackhall & Scott, to save the masons inhaling this fine dust; but it would have needed also to cover the nostrils to have been of great service. Besides, you cannot give a man whose lungs are healthy, a respirator to wear all day long without enervating him. You compel him to breathe a warm air to which he is not accustomed, and it comes to be a question, whether you do not do more injury to the lungs in one direction, than you prevent in another. Respirators are most serviceable to those whose lungs are injured, but no one would recommend a man with stout lungs to begin wearing one. No remedy has yet been introduced which the workmen have been found willing to adopt, while the mustaches and beard are but imperfect

respirators. As I hinted in my last Paper, the only effectual mode of doing good, is so to arrange their sheds, that the hewers may be saved from the fine dust entering their lungs; and that, as much as possible, they should only work at these hard stones in summer, when they can chisel them in the open air.

I was represented in some of the shorter newspaper reports of my last Paper, as saying that sandstones were the best building stones. I did not give an opinion on that matter at all. I said, that sandstones were better than marble for sculpture, as the rain would not wear down the fine lines. I had not occasion to discuss the question at all, as to the relative building value of limestones and sandstones. It would be presumptuous in me to give a dogmatic opinion on that subject. I think it is quite enough to say, that sandstone is *one* of the best building stones, without saying that it is *the* best. In Scotland, we have little experience of the use of limestone as a building stone; but when one finds, that to a great extent the architects have preferred a limestone for the Houses of Parliament, certainly I would not be dogmatic enough to affirm, that sandstone was necessarily better.

The other silicious stones can be disposed of in a word. Under the head of basalt, trap, or greenstone, we include igneous rocks — that is, rocks which are believed to have been melted by heat, like the volcanic lavas, and afterwards consolidated. There are only two of these rocks I shall stop to mention. The one is basalt, which we have all seen on Arthur Seat. Here is a fragment from Sampson's Ribs, smoothed on the outside by an ancient glacier. Basalt is a dark rock, very prone to throw itself into the columnar form in which we have it here and at Staffa. The other trap rock is what we call whinstone, or greenstone. It is mainly used

as road metal, in the causewaying and Macadamising of roads. It is occasionally employed as a building stone, but there is an objection to its use as such, from its difficult working, its hardness making it difficult to chisel. No one calls it a freestone. Its dark colour also makes it objectionable in our climate. I wish, however, to direct your attention to a softer greenstone, which is applied to a curious use in some countries and even in our own. It is called in our neighbourhood "Leck" Stone. Mr. Thomas Davies has obtained a specimen of it for me from Midcalder. It is very soft for a trap rock, and it has not the ordinary objection made to trap rock, namely, its difficulty of cutting. Even with a knife one can cut it with little trouble. It is very smooth, and when you rub it, the surface has a soapy touch. These stones are preferred for the insides of bakers' ovens, and for other places to which heat is to be applied. A stone of the same kind is largely used in Norway for the insides of furnaces. It has a remarkable power of resisting heat, such as the ordinary greenstones have not, and is less liable to crack and break or give way when so employed. Some such stones are also used in Lapland, Norway, and in India, for making pots and other vessels used in cooking. The peculiarity of this class of greenstones is, that they contain silica, and in addition, a large amount of magnesia. Magnesia is one of the most infusible bodies we know, and when united with silica, it forms a kind of stone more suitable than any other for resisting high heats.

A very beautiful rock is now coming into use as a building material in England and elsewhere, called Serpentine, from its being mottled like a serpent's skin. Those who visited the Great Exhibition, or have seen the Government Museum in Jermyn Street, London, may remember seeing large blocks of this serpentine. It consists of little else than silica, magnesia,

and oxide of iron, the latter of which serves to colour the stone green and red. It is a soft stone, not very suitable for out-door exposure, but admirable for inside pillars. It is more easily wrought than marble and is exceedingly beautiful. A rock analogous to serpentine is used as a building stone in our own country. It is the stone of which Inverary Castle is built — but is found on the opposite side of Loch-fyne. It is of a bluish colour, and so soft that it can be cut by a saw. The piece I show you was cut out for me by a clergyman of the Free Church, to whom I wrote requesting that he would get a mason to quarry a bit of the stone; but he borrowed a saw and cut it himself. This stone is used in Glasgow like "leck" stone, for bakers' ovens; and if touched, it will also be found to have a soapy feel.

This curious class of stones consists chiefly of silica, much of which is present in a body much softer than mica, called "Talc." Here is a very pretty specimen of talc from Shetland, which has something of the look of spermaceti, and when touched feels soapy. The Inverary stone has the peculiarity of being pliant, and of being easily cut and sawed into mantle-pieces and the like, by much simpler tools than are used for even our freest freestone. It hardens a little by exposure to the air, but never becomes very hard, yet it is capable of resisting much higher heats than harder stones.

The last class of silicious stones, which I merely name, are slates. They are the muds of worn-down rocks, converted by a process of consolidation into slates. Let us take, for example, the manner in which granite is ground down. It is sometimes ground down as a whole, and all its three constituents, quartz, mica, and felspar, deposited together. Here is the rock finely powdered, called Gneiss, which may be regarded as granite, and made up again into a solid stone — laminated as all these rocks are, showing that they have been

deposited in water, and often also twisted and contorted by exposure to powerful forces. One can see the white felspar here and there, the glistening shining mica, and, with a microscope, even the crystalline grains of quartz. It more often happens, however, that granite is reduced to a coarse powder and carried along in a stream, its ingredients becoming separated owing to their different density. The felspar in granite becomes a fine clay, and is carried furthest by the stream; the quartz which is heavier remains behind, and may form a sandstone. The mica is carried on further than the quartz, and very often predominates in sedimentary rocks, forming shining micacious schists. The name of Shale is given to a consolidated clay; when it gets hard, it is called a schist, and if very hard a slate, though in truth shales, schists, and slates, suffer imperceptible gradations into each other. They, however, have one character in common — they all have a more or less laminated or foliated structure. In other words, they are made up of leaves like this mica. Occasionally, nay frequently, they change, and all lamination ceases, and thus they form flag-stones or clay-stones. They are easily wrought, and sometimes used as building stones, as in Wales, but more frequently as paving stones. The term slate or schist is restricted to the hard muds when they present a splitting character, which makes them suitable for the roofing of houses. Without entering into their derivation from other rocks, I will only notice, that in many roofing slates mica predominates. Clay alone, thoroughly consolidated, forms the best roofing slates; so that in many parts of the country these splittable stones are called tilestone.

I referred in my former Paper to the appearance of plants that grow on stones, and I find on further consultation, that so little is known on the subject by botanists, that the whole question may be considered as one remaining to be studied.

It appears, that there is no class of stones on which plants do not grow, but the conditions of their growth are exceedingly uncertain. Here is a mass of rock from the Highlands, a part of which is the purest quartz — that is to say, it is all silica; a thing not containing one constituent on which a plant can exist, and yet it is covered with lichens. Professor Balfour has given me various examples of stones with lichens growing on them. They are from the museum in the Botanic Garden, where they should be examined in detail.

Transactions of the Architectural Institute of Scotland,
Session 1854–55.

No. III.

ON THE FORMATION OF PROVINCIAL MUSEUMS AND COLLECTIONS OF WORKS OF ART.

BY

CHARLES HEATH WILSON, Esq., A.R.S.A.,

GLASGOW.

[*Read at a Meeting of the Institute on 25th January*, 1855.]

Gentlemen,

In choosing a subject for the Essay of this evening — the first of a new Session of our Institute in Glasgow — I have been influenced by a belief, that a new era is dawning for art in this city, and by a wish to assist (so far as it may be in my power to do so) in giving a practical direction to the efforts now being made in different quarters for the promotion of the Fine Arts. There is much that is encouraging and gratifying in the movement which is obviously in progress; but the most sanguine amongst us can hardly hope, that unless it become more general; unless the enthusiasm which animates a few be more widely extended; unless a clearer insight into the value of the Fine Arts be more universal than it now is, we shall succeed in placing this great city in its true position in respect to those arts which adorn life, and which should perform a

most important part in the education and refinement of the people.

It is a profitable exercise of the spirit to contrast ourselves at times with others, and frankly to judge ourselves by the test. It would however answer no good purpose, to compare ourselves with the inhabitants of capitals which have been the seats of art for centuries, and who have enjoyed the benefits arising from the lavish expenditure of the national resources. Such a contrast would inevitably fail to excite any true sense of our real condition; or would perhaps only reconcile us to it. It is more likely to produce a wholesome influence if we institute a comparison between some provincial cities abroad and in our own country. And first, let me speak of the contrast in externals. Observe the evidences of industry, commerce, and wealth (of wealth of almost fabulous extent) which mark this city; our newly erected dwellings and costly public buildings, richly furnished shops, well-paved and well-drained streets; our crowded thoroughfares, well-dressed people, gay equipages, and other outward signs of prosperity and wealth; and then let us turn the mental eye to the striking proofs which may be seen elsewhere, of idleness, decay of trade, and poverty; to the crumbling edifices, grass-grown, neglected streets, desolate for the most part, or where trodden by people, indicating, in every respect, that prosperity has passed away, seemingly for ever.

The contrast is a striking one. What is it that induces us to travel far to visit the old city in its decay, poverty, and desolation. Is it merely to contrast its sad condition with our happier lot? Not so; but to examine the evidences which it can proudly show, of its use of a prosperity and power which once equalled ours; to mark and learn, as its inhabitants point to their collections of works of art, and

dwell with honourable pride on the names of the great men who adorn its annals, and whose works shed a glory on its decay. It is pleasant to hear these good people speak in glowing words of the use of their former wealth in the encouragement of genius, as they proudly point to the monuments of their renown. Travellers who visit our city inspect what it has to show with the cold or jealous feeling with which all are apt to regard the mere mechanism of gain; but they tread, with very different feelings, the consecrated pavements of the old city with which I have contrasted our young Capital of the West.

But not only do we find museums in these old and once prosperous cities, we find similar institutions for the instruction and recreation of the people in second and third rate provincial towns abroad, with not a tithe of the wealth of this great city; and these, not heritages from the past, but the creations of the present time. Other contrasts than these might be made; and there is one which appears to me peculiarly striking — I allude to that between our colonial empire and that of the French. The collection of Indian antiquities in the British Museum or India House, is miserably disappointing, and cannot be considered commensurate either with our opportunities, our resources, or to the interest of the subject; and our great Colonial cities are not distinguished by the possession of museums filled with interesting memorials of the races of men which we have subdued or displaced. Hardly had the French set foot in Algeria — whilst still they held an apparently doubtful possession of the soil — in towns, or rather frontier camps, one of the best buildings was converted into a museum, and the traces still discoverable of Roman dominion, and illustrations of native manners and manufactures were gathered together, and preserved for the instruction of the soldiery and the bold settlers who followed

their advance. I was much struck, some years ago, by a wood-cut in a French illustrated paper, giving views of the interior of the museum of one of these unsettled settlements. Here was evidence of the calm sense of superiority of the conqueror, and of his feeling of security — of his assertion of the strength and power of civilization, in a country so long abandoned to the worst form of barbarism, to the cruel desolating sway of the most savage of the followers of Mahomet. There was dignity as well as intelligence in the act. Would it have occurred to us as conquerors ?

We talk and write much about the education and refinement of the people. Let us again glance abroad. In countries where the very expression, " the people," seems tabooed ; where our favourite phrases regarding the amelioration of their condition are unknown ; where no press advocates their cause ; no true men speak openly in their behalf ; no false men trade in patriotism ; treasures of art and science are opened to their inspection without stint ; no merely vexatious regulations meet them at the door. As in their noble temples the prince and the peasant are seen humbly kneeling side by side : so in these museums the learned and the ignorant look on the same works, are equally proud of the men who produced them and the historic glories which they illustrate. I have heard words of true criticism and most impressive enthusiasm from peasant lips, recognitions of the unapproached greatness " di' nostro Rafaello," to use the expression of an Italian countrywoman standing before the Transfiguration of Raphael.

In these remarks I do not pretend to make a general comparison between the oppressed people of the south and the free inhabitants of our more fortunate country ; but however oppressed and weak, where a people have free access to the means of instruction afforded in the memo-

rials of their past success in the arts of civilization, and can glory in the names which have made their country renowned by genius and skill, there is hope of a new birth to greatness; and however free and powerful, where our people are systematically excluded from the sight and enjoyment of the proofs of our present refinement and progress in the arts, and never by the remotest chance see such testimonies of the national growth to greatness — of our progress from early times in art and science, or learn to be proud of our national history by its monuments — of its heroes by the memorials of them which art can alone provide, there is an element of decay.

Literature is now valued far above art, which has comé to be considered a mere minister to luxury. Its powers as historian and instructor are almost entirely overlooked, yet for ages it was both; and has it ceased to be either? The opened mounds of Nineveh and Babylon, and the sculptures discovered there — the penetrated tombs of Egypt, with their painted histories, have set us face to face with civilized people, who, more than 3000 years ago, had made a progress in many arts equal to that to which we have now attained. New chapters in the history of mankind have been opened to our wondering eyes; and whilst history has recorded little beyond the violence of men, art has supplied the hiatus in the bloody page; and although the vanity and weakness of kings have compelled art to chronicle their deeds of spoliation and the misery of their unhappy foes, it has not therefore neglected to represent man's progress in the arts of life — to illustrate his manners, habits, and customs, as he lived — his trade, manufactures, agriculture — all that we desire to know, and which is immortal in its interest — the humblest proof of progress in the arts of life at these remote periods, is now more interesting than the represen-

tations of the great king's slaughter of twice ten thousand. Art has the credit and the glory of dealing equally with peace and war.

We have over-estimated, in these days, the method of instruction, which has been so exclusively adopted, and we have under-estimated that so largely followed in other countries, and at other times. There are yet amongst us many to whom education through the eye is as necessary as it was before printing had worked its marvels; and whilst I hope that there will be a great increase of our efforts to enlighten the people by means of literature, I also trust that we shall see a revival of the educational employment of art in its highest and noblest sense.

It may be remarked, that we already possess local museums in many of our provincial cities—museums containing works of art; but what is our experience of them? are they readily accessible? are the works in them open for inspection, study, and transcript or copy? do they, in fine, answer any of the purposes for which such museums have been formed elsewhere? On the contrary, many of the valuable and instructive works of art which they contain, are as difficult of access as princesses in enchanted castles. In such museums, pictures and objects of natural history, sculpture, and New Zealand war clubs and paddles, bronzes and stuffed birds, illuminated manuscripts and Indian pagods, are jumbled together. They contribute nothing to the formation or benefit of a local school of artists, or for the guidance of public taste. The inutility of a collection of pictures buried in a college, was so strongly felt in Edinburgh, that when that University inherited an interesting collection, it was transferred to the National Gallery of Scotland, where it now is, and where it has aided in forming the taste and guiding the studies of many of our present school of

Scottish artists. But colleges ought to possess museums of art of a special character; in every University should be found the Glyptotheca and the Pinacotheca, which, besides other works of art, might contain an Iconographic series of great extent and variety, embracing the portraits of the heroes, statesmen, authors, and other great men, whose deeds or works are studied. There is no difficulty in carrying out this idea. The museums of Europe furnish the means; casts can be had of the busts of the great men of nearly every age, at a cost which renders it easy to form such a collection, and the youth proceeding to his class rooms, might pass through an avenue of images of the great, the learned, and the benefactors of mankind. Students occupied with history, might see in the Glyptothek of their College, each page illustrated by the ancients themselves — Grecian history by the Greeks, Roman history by the Romans. The arms, dresses, instruments, utensils, in fine, nearly every thing which it is thought so important to read about in our seminaries of learning, might be rendered as familiar to the eyes of the students as the description of them is to their thoughts, and this without difficulty, and at a cost which is absolutely trifling, when the benefits to be conferred are estimated. Whilst truer ideas on all these subjects would thus be formed, taste, and that appreciation of the arts which ought to be an accompaniment of our civilization, would take the place of that absence of both which we are painfully called upon to acknowledge.

From College Museums of Art I turn to Municipal Museums — these have yet to be created: To take one item of a municipal museum — architectural designs — let us think for a moment what London might have possessed, had the municipality but entertained the idea which I now

present to you—had the plans, elevations, perspective views, and models of all the buildings, which, since the time of Sir Christopher Wren, have been successively laid before that great corporation been preserved in one place. Consider for one moment the priceless value, the indescribable interest of such a collection. When in London with my colleagues of the Council, we visited dusty depositaries in search of such municipal treasures, we found one sketch by Wren, the sketches by Thornhill for his Chiaroscuri in the Cupola of St. Paul's, and very little sketches they were, and besides these, thickly coated with dust, some half dozen models of city improvements. Our municipalities pay for drawings and models, it is only necessary to frame, glaze, register, and preserve them. I think that I need hardly speak of the value of such collections, for reference, for instruction, and for a variety of purposes which must present themselves to your minds.

When museums are spoken of, I have no doubt thoughts instantly cross the minds of all, of rare and precious marbles and bronzes, of costly pictures by the great masters, and of other works of art of equal rarity and value, and it may be, that this idea of museums deters from all attempts to form them, seeing that the cost of such collections is so great; but I look at the whole subject from a totally different point of view, from one which, instead of presenting us with the prospect of an outlay which it would be hopeless to attempt to meet, renders a collection of works of art of standard excellence comparatively easy and economical.

It is desirable to preserve original and precious works of art in a great central museum in the metropolis, and it seems reasonable that the power and wealth of the nation should be principally concentrated upon this central collec-

tion, yet provincial museums should be furnished with casts of the sculpture, and copies of the pictures, electrotypes of the bronzes, and such transcripts or imitations of other works of art as could most readily be made by a staff of artists employed for the purpose in the central establishment.

By means of casts, all the beauty of form of the original is rendered with such perfect fidelity, that they may be termed in every respect, except material, duplicates of the original works. This system has been acted upon at Berlin; and a suggestion which I had the pleasure of submitting to the Royal Scottish Society of Arts in 1836, has been completely realized by Monsieur D'Olfers, the director of the Gallery at Berlin, to whom the same idea had occurred, and who has been enabled, by the liberality of his government, to form the most perfect collection of casts in the world, illustrating the whole history of art during a period of 3000 years. By a process which he was so good as to describe to me, these casts have been rendered durable, their appearance much improved, and their resemblance to the original works increased. Preserved in a series of halls, quite unsurpassed in beauty and fitness, they are chronologically arranged, and certainly form the most perfect and interesting series existing.

The electrotype process, by which statues and other works in metal may be copied for provincial museums in a perfectly satisfactory manner and at a very moderate cost, is another apt and economical method of furnishing provincial museums with faithful copies of fine works of art.

Having thus briefly considered the best methods for providing Provincial Museums with specimens of sculpture, let us now turn to Painting. At first sight the difficulty of

forming collections of fine paintings may seem insuperable when the cost is considered. But let us think for a moment. Take, for instance, one of Raphael's master-pieces in the Vatican — the noble composition and grouping, the fine drawing and ideal treatment of the figures, the harmonious and at the same time grand and monumental style of colouring, the dignity of pose and beauty of the figures, can be rendered in faithful copies by skilful hands, as we know, in a most satisfactory manner, and for the very purposes which I am now pointing to; for the governments of the Continent, including that of Russia, have long since secured such copies for the instruction and guidance of their artists, and for the gratification of the people. Had we possessed a collection of copies of the works of the great masters, I believe that our taste would have been more advanced than it now is, and that historic art would have held a higher position than it does at present. The procuring such copies would have indicated a higher sense than has yet existed of the nature and value of high art, which I need not say we have notoriously neglected. The master-pieces collected in our central museum would thus be made available for the diffusion of taste and instruction throughout the kingdom. I would also employ artists to copy important works in continental collections, both of fine art and decoration, being able to state that this can be done in the most satisfactory manner for a very small outlay. Thus the works of the great masters might be brought to our very doors. The frescos of the Sistina and the Stanze, of the Farnesina and the Farnese of Sa. Maria Novella, and the Carmine, of the Cathedrals of Orvieto and Sienna, of the Palazzo del T, the choice decorations of the Loggia; in fine, all that has been done in past times might be made available for the welfare of the present,

and the instruction of that majority which cannot hope to see the originals.

The deeply interesting and perfectly unequalled collection of drawings, representing the most remarkable edifices of the middle ages in Italy and Germany, which, at so much cost and pains, has been formed by Dr. Puttrich of Leipsic, and a portion of which he has so nobly consented to exhibit within these walls, suggests another method of providing a museum of art with specimens invaluable to artists of every class and to the public generally. What has been done by a private gentleman — and so admirably done — might be successfully imitated by a public body desirous of encouraging art and improving the people. The collection of Dr. Puttrich is for sale, and I would express a sanguine hope that it may find a home in this country. Consisting of about a thousand drawings, it is as unique as it is valuable and interesting; the drawings are exquisitely executed, with all that fidelity and truth for which the German artists are famous. It has been thirty years in formation, and strongly sensible as I am of its value, I ask your sympathy and aid in securing it for a Museum which I trust I am not too sanguine in believing we shall soon possess.

But a museum should not be restricted to such works as those which I have described — the locality must be considered, the nature of the manufactures must be a guide in selecting some of the works for preservation and exhibition within its walls. Such is the connection between all branches of the fine arts, that no single one can be excluded from a collection without damage. This vital principle has not been sufficiently understood — at any rate, it has not been sufficiently acted upon in our day. The whole history of art shows us, that the minor branches of design have flourished or the reverse, precisely in the ratio of the influence of the

high class artists upon them, and the union between them; and no one who has studied this history in the works of former times, can doubt for a moment that the present condition of art, and the low state of taste in decoration, design, and manufacture, are owing to the divorce now subsisting between the different branches of the fine arts — their independence of each other is purchased at the price of their decline.

I would now request your attention to a few remarks which I have to offer upon another section of my subject. We have filled our great collections with foreign works, but we look in vain for those of native production. Whilst we boast of a number of monuments, illustrating in a most interesting manner, the varied and fluctuating history of art in this country, from the period of Roman dominion to the present time, we look in vain for any national collection in which to study this interesting history. We appear to be hardly sensible of the duty of preserving the originals. I have visited Iona with a band of tourists, and have witnessed the savage ignorance with which the majority trod upon old and valuable national relics and aided in their defacement. There was no one to forbid this miserable profanation, this unpardonable savagism — repeated, doubtless, by every boat-load of visitors.

It is true, that of late steps have been taken to preserve our ancient buildings for future ages. I hope that the feeling is becoming universal; but I have known things done to invaluable national property of this kind, connected as it is with our history as a people, which, if related, would make the hair of the lover of art stand on end, and which can be paralleled only in Turkey or Egypt.

I propose to make a complete series of casts illustrating the rise, progress, and decay of Scottish art, by means of the

monuments scattered over the mainland and neighbouring isles. To do this would be no costly undertaking, the number of specimens remaining is, alas, too small to render it either difficult or expensive. I can hardly doubt, that every one present would rejoice to see a portion of a local museum appropriately fitted up and arranged, presenting in chronological order a series of Scottish works of art, proving our connection with the great family of nations, illustrating the history of our national struggles, of our monarchs, of the noble families and the heroes of every class, whose names and memories are sacred to us. I feel that I cannot overstate the value and interest of such a collection, and its benefit as a means of instruction.

To return for a moment, before concluding, to the comparison with which I started. Venice, Genoa, Pisa, were great commercial cities in their time—their merchant princes had, like ours, their town and country residences — they had the same love of fine furniture, plate, equipages, and the other accompaniments of wealth — they erected, as we have done, public statues in their streets and squares, and have not been excelled in the extent and magnificence of their public works; but they did much more than this, nor did they consider that enough for the glory of their country or the gratification of the people. Their history was chronicled, so to speak, by the hand of the artist on every available space — the walls and ceilings of public halls and chambers glowed with the productions of the painter's art appealing to patriotism — the very exteriors of buildings were covered with commemorative works of sculpture and painting. On every side the Italian of those days saw the fairest forms of art commemorating the truths of his religion and the greatness of his country; and although her greatness be decayed, these works pre-

serve for Italy a place in the affections of mankind which she never can lose. I wish we could profit by and imitate her example; at any rate, let us follow that which she now offers us, that in which all other nations have been her pupils, the establishmcnt of free museums, and free libraries, not only in her capitals but also in her provincial towns.

I would here guard myself against an accusation which is often brought against the advocates of the earnest study of the art of past times, and which I have been frequently subjected to, that such study is conducive to mere copyism, and to the creation of a school of artists merely imitative and devoid of all originality. It is hardly worth while to do more than to mention an argument, which, if urged without, as it sometimes is within, the pale of art, would be subversive of all education founded on a judicious study of the works of eminent men of all times. So far as the artist is concerned, originality is never depressed in the mind of genius by the study of the antique; and if mediocrity imitates, the world is a gainer, inasmuch as such imitation is infinitely better than such originality as unguided mediocrity is capable of. I may be permitted to quote a few lines from Goethe on this subject — "He who ceases to hold communion with the masters of art can never make progress, while he is in danger of going back." "To have promoted the artistic cultivation of a distinguished natural talent is matter for honest pride." "In our time, the merit is greater than formerly, when beginners had faith in schools, and rules, and masters, and when they modestly put up with the grammar of their art, which is not the case with the young men of the present time." "The artists of Germany" (and I would add of Great Britain) "have for the last thirty years believed, that

every talent is its own teacher; and in this belief they are confirmed by a legion of enthusiastic amateurs. Many a time I am told that such an artist owes all to himself. Sometimes I put up with it, but sometimes, too, I retort, that he has, after all, very little reason to be proud of his master." "If you would create something, you must be something. Dante is a great man, but he had a civilization of centuries to support him." I might quote further, but it is needless — I am reminded of the common Italian proverb — "Chi s'insegna ha un pazzo per maestro."

I have occupied so much of your time with the remarks which I have made upon the first portions of my subject, that I shall not detain you at any length with the last section of my proposed Museum, but shall merely remark, that it ought to consist of productions of the minor branches of art, or of well-executed casts and drawings, which of course are far more easily attainable than original works. Works in metal of every kind, in wood, glass, china, and earthen ware; in fact, manufactures of every class, to the perfection of which the arts of design are necessary, should be illustrated by these means. In this our exhibition of arts and manufactures — in the series of pictures, casts, drawings, photographs, painted glass, bronzes, porcelain, woven fabrics, and other ingenious and beautiful productions of the artist and manufacturer, you have placed before you an outline of the kind of Museum which I think it so desirable to form, and which I have endeavoured to show may be easily formed at a moderate expenditure.

I ought not to omit allusion to the mechanical arts, in the practice of which this great city is so deservedly renowned. No museum here would be perfect without its marine department, offering us, by means of models and

drawings, a complete view of our progress in the art of building ships of every elass. Did such a museum exist, can we doubt that our shipbuilders would hesitate to ehronicle their names within its walls. Models also of those wondrous maehines used in manufacturing processes, whieh have made Glasgow so rich and powerful, would also find a plaee within our Museum, to guide and instruet generations yet unborn; but I need not dwell upon these ideas; it is enough, on an oeeasion like the present, to draw the outline; the filling up of the pieture must be a work of time and thought. I trust that I have shown, that within limits which eannot be considered either narrow or unfavourable, the enterprise in favour of which I appear before you as an advoeate this evening, presents no diffieulties which may not be easily overeome.

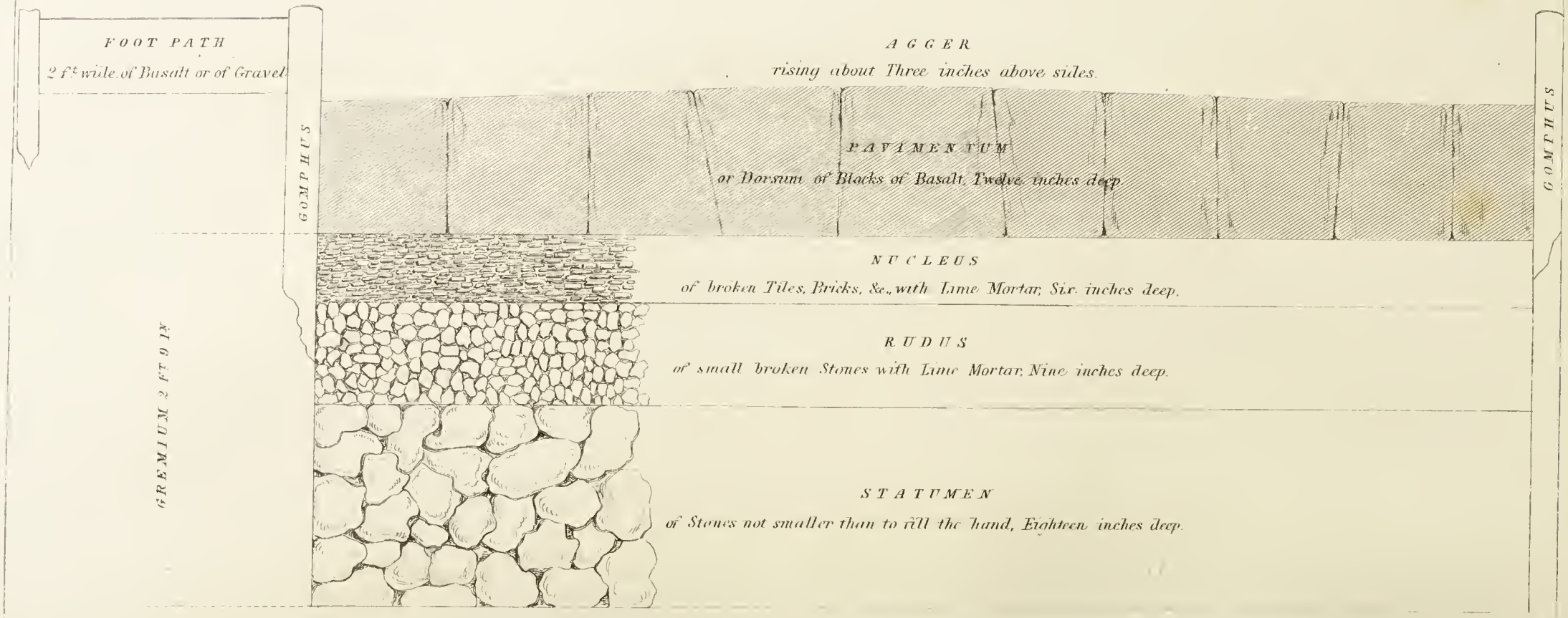
This has been an auspieious day for the progress of the arts in Glasgow—the people of Seotland, in the persons of their chief magistrates, assembled in these halls this day to do honour to art, to recognize its elaims, to advoeate its extension. In expressions glowing with kindly and patriotie feeling, in a spirit of love and brotherhood, art was spoken of as an honour to a nation, as its instruetor as well as its useful servant; and I would express my deep and heartfelt sympathy with the sentiment with which art was alluded to as a means of ameliorating the condition, of refining the sentiments, and of improving the manners and habits of our poorer brethren.

Art has nobly served the Church; it has ministered to the exigeneies of the State; it has a duty yet to perform—to elevate and improve the poor.

I need not deseribe the dens in which the poor dwell, in our great cities; but every one who enters them, must feel

that the architect must precede the missionary, or vain will be his sacred labours.

Filled with these and many other such thoughts of the nature and importance of our profession and its duties, we have placed before our countrymen this collection of works of art and manufacture for the gratification of all classes; and I trust that our efforts will not have been in vain, and that in future days, when in the possession of a noble Museum, Glasgow will have reason to remember with a kindly feeling the men who in a spirit of earnest purpose laid its foundation.


FOOT PATH
2 ft wide of Basalt or of Gravel
GOMPHUS
AGGER
rising about Three inches above sides.
PAVIMENTUM
or Dorsum of Blocks of Basalt, Twelve inches deep.
GOMPHUS
NUCLEUS
of broken Tiles, Bricks, &c., with Lime Mortar, Six inches deep.
RUDUS
of small broken Stones with Lime Mortar, Nine inches deep.
GREMIUM 2 FT 9 IN
STATUMEN
of Stones not smaller than to fill the hand, Eighteen inches deep.

SECTION OF ROMAN ROAD WAY

Twelve feet wide; Total Depth from bottom of Gremium to top of Agger Four feet.

Transactions of the Architectural Institute of Scotland,
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No. IV.

ON

THE ROADS OF THE ROMANS.

BY

ALEXANDER THOMSON, Esq.

BANCHORY.

[*Read at a Meeting of the Institute in Glasgow, held on 22nd February*, 1855.]

The highways of the Romans are a marked and peculiar feature of their polity; they stand pre-eminent among the works both of the Republic and the Empire, alike for usefulness and for durability.

To us moderns, accustomed to regard roads as the first and most essential step towards the improvement of a country, it is not easy to realize the idea of a people prospering and advancing in civilization without their assistance. Yet so far as we know, many of the most civilized nations of antiquity, the Babylonians, the Persians, the Egyptians, and the Greeks, possessed nothing which can be regarded as a system of public roads.

In eastern countries, goods seem to have been transported from the earliest periods as at the present day by caravans, on the backs of camels or horses, and to the soft foot of the camel, a paved road would have speedily been fatal, and not much more advantageous to the unshod hoofs of horses; and even for their war chariots the firm turf of the open plains was better adapted than a hard road.

In Egypt, the Nile was the great highway, effectually opening up the country from one end to the other, and giving easy access to every part, aided in the Delta by canals. Mounds, too, from an early period were erected in Lower Egypt for the purposes of irrigation, and it is evident that they would answer at the same time as roads, especially during the months of inundation.

In Greece, again, the country is broken and intersected by arms of the sea, and thus access to most parts by it was easy, as well as to all the colonies on the coasts of the Mediterranean, so that great public roads seem to have been unknown.

In Palestine, however, there are traces of the existence of artificial roads from a very early period.

In the Bible, and especially in the prophetical books, the allusions to roads, prove that they were well known, otherwise the force of the splendid figures employed would have been wholly lost. We have no clearer instance of this than in the noble prophecy in the 40th chapter of Isaiah, where the types are all taken from the construction of a long and important line of road, and unless the Jews had been familiar with the operations and results of road-making, the words employed would have conveyed no ideas to their minds.

We read of various roads among the Jews in the earlier periods of their history.

In the account given of the institution of the Cities of Refuge for the Manslayer, distinct provision is made for the necessary roads in the words—"Thou shalt prepare thee a way." To this short command the Rabbins have added many minute injunctions. They made it the business of the Sanhedrim to make these roads convenient, by widening them, by removing every obstacle which could hurt the foot

or hinder the speed; every hillock was to be levelled, and bridges plaeed across rivers and brooks; and at every turning, posts were ereeted to guide the fugitive, having the words, Refuge, Refuge, inseribed upon them.

In Numbers xx. 17, we read, "We will go by the king's highway." Again, in Samuel vi. 12, we are told, that "The eattle went along the highway lowing as they went, and turned not aside to the right hand nor to the left."

These brief notiees, however, though suffieient to prove that roads existed in Judea, give us no knowledge of their eonstruetion; and the only elear aecount of a Jewish road of whieh we are aware, is in a short passage of Josephus, who, in his Antiquities, viii. 7, 4, tells us, "Solomon did not negleet the eare of the ways, but he laid a eauseway of blaek stone (basalt?) along the roads that led to Jerusalem, both to render them easy to travellers, and to manifest the grandeur of his riehes." This is very like the description of a Roman pavimentum; but Josephus is so mueh inelined to exaggerate every thing in favour of his nation, and especially its wisest king, that it would have been satisfaetory to have had independent proof to eorroborate his statement.

Assuming it to be true, that these roads of Solomon's were constructed of basalt, then this work must have been aceomplished 250 years before the foundation of Rome, and 700 years before the eonstruction of the Appian Way.

Were we firmly persuaded of the truthfulness of this passage of Josephus, there would be eonsiderable reason to eonelude, that the Romans indirectly received from the Jews their system of road-making.

We know the intimate relation whieh existed betwixt Phœnieia and Judea, sometimes friendly, generally hostile, but still sueh as to eause eaeh to have a perfeet knowledge of every important art whieh the other possessed. We know

that Carthage was the daughter of Tyre, and of course inherited all her useful acquirements; and we are told expressly by Isidorus, that the Romans learned the art of road-making from the Carthaginians. But for this positive assertion, we should have been rather inclined to look to the Etruscans as the teachers of the Romans in this as in many other useful arts.

Though public roads were not the original invention of the Romans, they have the merit of carrying out the system to an immense extent; one of the many enduring proofs of their remarkable practical sense, the quality to which, more than to their military skill and courage, we attribute the long duration of their rule, and the deep impress they have left to the present day on the laws and the customs of the nations of modern Europe.

The passage of Isidorus to which we have referred, is short but perfectly explicit—"The Carthaginians are said to have been the first to have paved roads with stones, afterwards the Romans constructed them almost over the whole earth, for the convenience of travelling, and that the people might not be idle."*

The Roman roads were in their highest perfection during the earlier period of the Empire, and we have notices of them in various writers of that age, who seem to have regarded them with profound admiration.

Dionysius of Halicarnassus classes them along with the aqueducts and cloacæ, as the three greatest wonders of Rome. "Among the three most magnificent structures of the city of Rome," he says, "from which the greatness of

* "Primum autem Pœni dicuntur lapidibus vias stravisse, postea Romani eas per omnem pene orbem disposuerunt propter rectitudinem itinerum et ne plebs esset ociosa." — Isidor. Origs., Lib. xvi., de Itineribus.

the Empire most clearly appears, I place the aqueducts, the construction of the roads, and of the cloacæ, regarding not only the usefulness of the works, but the greatness of the expense."*

Strabo, the geographer, comparing the Greeks and the Romans, tells us, that "the Romans paid most attention to things which the Greeks overlooked, the paving of roads, the construction of aqueducts, and of cloacæ, capable of conveying the filth of the city into the Tiber. They also constructed roads throughout the country, cutting down hills, and filling up hollows, so that cars on wheels might receive and transport the cargoes of ships."†

About thirty principal roads issued from the various gates of Rome, or diverged from each other almost immediately after leaving the city. Each of them had many branches starting off in various directions, as they pursued their course to the furthest limits of the Empire, and as ancient writers have not been very careful to distinguish betwixt the names of the great lines and of the branches, the latter being often mentioned by the name of the former, it has become extremely difficult to reconcile the names given in the Itineraries with the incidental notices which occur in classical authors.

* "Εγωγε οὖν εν τρισι τοις μεγαλοπρεπεσατοις κατασκευασμασι της Ρωμης, ἐξ ὠν μαλιστα το της ἡγεμονιας εμφαινεται μεγιστον, τας δε των ὑδατων αγωγας τιθεμαι, και τας των ὁδων στρωσεις, και τας των ὑπονομων εργασιας, ου μονον εις το χρησιμον της κατασκευης την διανοιαν φερων, αλλα και εις την αναλωματων πολυτελειαν."—Dionys. Halicarn. Lib. iii. cap. 91. Antiq. p. 200.

† "Ουτοι (Ρομαιοι) προηνεγκαν μαλιστα ὠν ολιγωρησαν εκεινοι ('Ελληνες) στρωσεως ὁδων και υδατων εισαγωγης και ὑπονομων των δυναμενων εκκλυζειν τα λυμματα της πολεως εις την Τιβεριν,—Εστρωσαν δε τας κατα την χωραν ὁδους, προσθεντες εκκοπας τε λοφων, και εγχωσεις κοιλαδων ὡστε τας αρμαμαξας δεχεσθαι πορθμειων φορτια." Strabo, Lib. v. p. 360.

We have full details of all the great roads of the Empire from three aneient sources. The Itinerary of Antoninus, the Carta Peutingeriana, and the Itinerary of Bourdeaux. The first is an offieial work, prepared and published during the reign of Antoninus, detailing the distanees and post stations on all the great roads from Rome to their termination; in short, the government *Bradshaw* of the seeond eentury. This is the most important authority on the subjeet. The other two are of more reeent and uncertain date. The Carta Peutingeriana is a road map, extending from Britain to the Ganges, exeeedingly perplexing, yet often giving useful information; and the third is the Itinerary of a pilgrim from Bourdeaux to Jerusalem, and it is quoted by some writers as the Bourdeaux, and by others as the Jerusalem Itinerary.

There are twelve roads whieh deserve to be named as deeidedly more interesting to us from elassieal assoeiations, and more important in themselves than the others.

1. The *Via Flaminia*, eonstrueted by the Consul Flaminius, who fell in the battle of Thrasimene, is the great north road, which, as noticed in a former paper, issued from the Porta Flaminia, very near the present Porta del Popolo. The modern road from the Ponte Mollé, about two miles from the gate, by whieh travellers from the north enter Rome, appears to be on the exaet line of the aneient Via, though no part of its structure is seen. Immediately after passing the Tiber, the modern road to Baecano diverges from the aneient Flaminia into the Cassia.

2. *Via Salara* or *Sabina*, leaving by the Porta Salara, and leading to the country of the Sabines.

3. *Via Nomentana.* A branch from the Salara, leading to Nomentum. About fifteen miles from Rome, and issuing from the Porta Nomentana.

4. *Via Tiburtina.* From the Porta of the same name, now Porta San Lorenzo, to Tivoli, and on to Subiacum.

5. *Via Gabina* or *Prænestina.* From Porta Prænestina, now Porta Maggiore, to Gabii and Præneste.

6. *Via Labicana.* From the same gate, and extending to Labicum.

7. *Via Appia.* The great south road, issuing from the Porta Capena, and extending to Brundusium, and having many important branches, as the Albana, Ardcatina, Campana, Domitiana, and others.

8. *Via Latina*, which diverged from the Appia, immediately on leaving the ancient gate, considerably within the modern walls and led into Latium.

9. *Via Ostiensis.* Down the left bank of the Tiber to its mouth at Ostia, with branches, especially the Laurentiana and Severiana, extending along the coast, through the Pontine Marshes to Terracina.

10. *Via Portuensis.* Along the right bank of the river to Portus.

11. *Via Aurelia.* Forming the communication with Etruria, and leaving Rome by the Porta Aurelia on the summit of the Janiculum.

12. *Via Triumphalis.* A branch from the Via Cassia, six miles long, by which passed the Triumphs, those much coveted but most barbarous rewards bestowed by the Romans on their victorious generals. It came along the high ridge of the Monte Mario, commanding one of the noblest views of Rome, descended rapidly to the plain, and entered the city near where St. Angelo now stands, whence the procession advanced across the Tiber, by the Pons Triumphalis to the Capitol. This road was used for triumphs from the north; those from the south arrived by the Via Appia.

Of these great roads the oldest are supposed to be the Gabina and the Salara. The Gabina is only nine miles in length, and it is repeatedly named by Livy in describing the war with Porsena (Lib. ii. c. xi. A. R. 247), and also on occasion of the defeat of the Gauls by Camillus, A. U. 363, at the eighth milestone of this road. The Via Salara is named by Livy (Lib. vii. c. 9), as the road on which the Gauls encamped, A. U. C. 392, and it is probable that it was even then an ancient road, because it led to the country of the Sabines, with whom the Romans had intercourse sooner than with any of their other neighbours. It is asserted by Festus (in Voce Salaria) to have derived its name from being the road by which salt was conveyed from the sea to the Sabines, and it is further said, that the first salt-works were established by Ancus Martius; and the two traditions combined would make the Via Salara the more ancient by many years.

It is however altogether improbable, that these early roads were constructed in a manner at all approaching to the care and expense which were bestowed upon them in after times.

The Romans had many distinctive appellations for the different varieties of roads.

The great roads, such as the twelve above named, and many others, were termed Consular, Prætorian, or Military. The word viæ implies roads wide enough for carriages, and was also applied to the streets of towns.

It is of course in vain to look now for remains of any but the principal and best constructed roads; all the others have been effaced by the changes which have taken place on the surface of the earth.

Near the tomb of Cecilia Metella, however, a paved foot-path, four feet wide, is known to exist; but it is at present covered by the soil, and it is an almost solitary example.

Many remains of the great roads are to be found near Rome, and not unfrequently modern operations enable us to see sections of the whole ancient road-way. The traveller still drives for miles together on the ancient pavement of the Via Appia, while exploring the ruins on either side of it. He climbs the steep ascent to Tusculum, treading the same stones on which Cicero trode on his way to his Tusculan villa, and still finding the fifteenth milestone marking the distance from the capital, and if he ascends to the site of the temple of Jupiter Latialis, on the summit of the Alban Mount, he will find stones with the letters V. N., *i. e.* Via Numinis, still retaining their positions after a lapse of more than two thousand years.

Other excellent examples occur near Præneste, where even the side footpaths remain entire, and also on the Via Ostiensis. In the vicinity of Rome, and of other towns, they have often been torn up to employ the materials for purposes of war.

The great roads may be traced not only near Rome, but even to the utmost boundaries of the Empire, from the

pillars of Hercules to the banks of the Euphrates. From the provinces of Africa and Upper Egypt, even to the "Toto penitus divisos ab orbe Britannos."

The construction of roads was an essential and an influential part of the Roman policy. It commenced at an early period, while the Republic was yet struggling for independent existence with its nearest neighbours, and it continued until the Empire began to decay, until almost the whole known world was covered by a web or net-work, whose centre was the capital. Wherever the Roman power established itself, there roads were made and maintained; and sometimes, as in the case of Scotland, even in countries which the Romans could scarcely boast of having subdued.

There were two great objects to be attained by this; facility of military communications, and the gradual amalgamation of the most distant provinces into one great empire.

The first was natural in a people to whom war was both business and pastime. No other nation ever was so long and so steadily warlike, or so dependent on war for existence, and when the Romans ceased to conquer and to extend their Empire, immediately their power began to decline.

The Romans employed various means to bind together the heterogeneous mass which composed their Empire. Just and equal laws, toleration, or perhaps rather indifference to religion, at least until Christianity appeared, and the communication of civilization and literature.

The system of roads formed one of the most efficient bonds of union; for, by opening direct communication betwixt the capital and every part of the Empire, it gave the most distant tributaries a certain degree of interest in the

Imperial City, and attached them to it. While by facilitating the transport of troops, it was one great means of enabling the falling Empire to struggle so long against its invaders.

Most of the great nations of antiquity fell in a few years, some even in a few days; but if we regard the capture of Constantinople by the Turks as the final termination of the Roman power, we find that as many centuries were spent in destroying as had been required to erect it.

From notices which occur in various authors, we are able to acquire a tolerably correct idea of the mode in which Roman roads were managed, and it is curious to find, that in some particulars, the system was somewhat similar to our own.

During the earlier ages of the Republic, both roads and streets appear to have been under the care of the Ædiles. Afterwards we hear of four magistrates, with the title of *Quatuor Viri Viarum;* but it is at least doubtful if their powers extended beyond the streets of the city; for Pomponius, in describing them, uses the ambiguous expression, "Qui curam viarum gesserent,"* and Dio Cassius expressly restricts them to the streets.†

Both these writers are long subsequent to the time of the appointment of which they speak.

In the later years of the Republic, the charge of the roads appears to have legally belonged to the Censors, of which we have an illustrious example in the Appian Way, constructed by the censor Appius Claudius.

* Pand. I. di Orig. Jani., L. ii. § 19, 20.

† "Οἱ δε τεσσαρες, οἱ των εν τῃ Αστει ὁδων επιμελουμενοι." — Dio. Cass., Lib. liv. p. 618.

Numerous inscriptions still remaining, commemorate the construction or repair of roads by Censors, and also prove that Consuls, as commanders of the armies, had a right to make roads; and further, that the Tribunes of the people often encroached on these privileges and usurped the power.

The construction or repair of roads seems indeed to have been a common means of acquiring popularity in all periods of the Roman history, and to have been specially employed for this purpose by turbulent citizens. Caius Gracchus, Plutarch tells us, while tribune, devoted particular attention to them, "not only as regards their usefulness, but also their beauty and adornment."*

His example was copied in this respect by the tribune Curio, who brought forward vast plans for the improvement of the public roads, and besought the people to elect him to his office for five years, to enable him to carry them into effect.† It is to this that Cælius refers, in writing to Cicero, as a popular device, comparing it in this respect with the Agrarian law, and giving it the title of *Lex Viaria*.‡

The Appian Way affords another illustration; for we find from Diodorus, that in order to construct it, Appius Claudius emptied the public treasury against the will of the Senate, but to the great satisfaction of the people.§

* "Εσπουδασι δε μαλισα περι την ὁδοποιιαν της τε χρειας ἁμα και το προς χαριν και καλλος επιμελητεις."—Plutarch in C. Gracchi Vita, C. vii. p. 837.

† Appianus de Bello Civili, Lib. ii. p. 443.

‡ Levissime enim (Curio). . . . transfugit ad populum, et pro Cæsare loqui cœpit, legemque Viariam, non dissimilem Agrariæ Rulli, et Alimentariam, quæ jubet Ædiles metiri, jactavit."—Cicero Epist. Famil., Lib. viii., Ep. 6.

§ "Τω Δημω γαρ το κεχαρισμενον ποιων, ουδενα λογον εποιειτο της Συγκλητου."—Didor. Siculus, Lib. xx. c. 36.

The greatest men did not consider it below their dignity to take charge of a line of road. Julius Cæsar was for a considerable time curator of the Via Appia — probably previous to his expedition into Gaul — and Plutarch assures us, that he spent a considerable amount of his private fortune in the work.* Whether or not this was one of Cæsar's stepping-stones to aid his progress to the dictatorship, we cannot tell.

Both during the Republic and under the Emperors, we find that occasionally the care of a particular road was assigned to an individual who held no other public office. Cicero mentions a certain Thermus, as curator of the Flaminian Way.† At a long subsequent period, Pliny the Younger expresses extravagant joy on account of his friend Cornutus Tertullus being named curator of the Æmilian Way — "When I heard that Cornutus Tertullus had received the care of the Æmilian Way, I cannot express my delight both on his account and my own. I should extend my letter to an infinite length were I to indulge my joy."‡ Unless the office had been both honourable and important, Pliny could scarcely have written in such terms regarding the appointment.

After the Republic was overthrown, the Emperors assumed this function to themselves, and usually discharged its duties by means of the Quæstors and Ædiles.

* "Επει δε τουτο μεν όδου της Αππιας αποδειχθεις επιμελητης παμπολλα χρηματα προσαναλωσεν των έαυτοῦ." — Plat. in Cæs., c. 5.

† "Thermum . . . propter quod curator est Viæ Flaminiæ." —Cicero ad Atticam, I. 1.

‡ "Cum mihi nunciatum est Cornutum Tertullum accepisse Æmiliæ Viæ curam, exprimere non possum quanto sim gaudio affectus, et ipsius et meo nomine. . . . in infinitum epistolam extendam si gaudio meo indulgeam." — Plin. Epist. V. 15.

It was evidently considered as one of the most honourable and most popular of their duties. Many inscriptions remain *in situ* commemorating their road operations, and they are often recorded by their biographers, and occasionally stamped upon their coins.

Of the Emperors the greatest road makers were Augustus, Vespasian, Trajan, Hadrian, and Marcus Aurelius.

Under Augustus, the prime minister and favourite, Agrippa, thoroughly repaired the whole roads, while ædile, at his own expense,* in the year of Rome 720. The Emperor himself repaired and embanked a large portion of the Flaminian Way, and obliged many of the senators to repair other roads,† on which occasion probably he erected the celebrated golden milestone in the Forum (*milliarium aureum*).

On this milestone were engraved the names of all the great roads, with the distance from Rome to their several terminations, in miles of 1000 double paces. The roads were however not measured from this milestone, but from the several gates by which they issued from the city; as was clearly proved by the discovery of the first milestone of the Appian Way, in its original site in the Vigna Naro, exactly one mile from the Porta Capena. This milestone was, with exceeding bad taste, removed from its proper place, and now stands at the summit of the principal ascent to the Capitol.

On the same occasion, probably, two different medals of Augustus were struck, with the inscription, "Quod Viæ Munitæ Sunt," which are engraved in Nardini.‡ Aurelius Victor notices the repairs of the Flaminian Way by Vespasian

* "Πασας δε τας ὁδους, μηδεν εκ του δημοσιου λαβων, επεσκευασε."—Dion. Cass. Lib. xlix., An. 720.

† Dio. Cassius, Lib. lviii. p. 585.

‡ Nardini Roma Antica, Vol. i. pl. 1.

—"Throughout all lands where the Roman law prevails, the cities were restored in excellent taste, and the roads repaired by immense works and mountains cut down on the Flaminian, to obtain a gentle slope."*

An inscription in honour of this operation still remains *in situ* at Forli—

IMP. CÆSAR. AVGVSTVS
VESPASIANVS. PONT. MAX
TRIB. POTEST. VII, IMP. XXVIII. COS. VIII
CENSOR. FACIVND. CVRAVIT.

In many places similar extensive works may still be seen, though they are often passed unnoticed, the lapse of time having given a natural appearance to the artificial face of the rock; and they must have been executed at enormous expense before the discovery of gunpowder.

Trajan, besides his great works in Germany, constructed a new line of road from Beneventum to Brundisium—

VIAM. A. BENEVENTO.
BRVNDISIVM. PECVN.
SVA. FECIT.†

Hadrian made a road seventy-two miles in length from Chiusi to Florence.

It is superfluous to multiply instances of the care and expense bestowed by emperors on the public roads; there is scarcely one emperor who is not proved by inscriptions or coins to have attended to this branch of the public service.

* "Per omnes terras quo jus Romanum est urbes cultu egregio, viæ que operibus maximis munitæ, et cavati montes per Flaminiam prono transgressu."—Aurelius Victor de Cæsar, C. ix.

† Gruteri Thesaurus Inscript., p. 151.

Even the Goths were sensible of the importance of the highways; for there still remain inscriptions at Terracina, and at the Post Station at Mesa, ten miles distant, commemorating the repair of that part of the Via Appia which traverses the Pontine marshes, by their King Theodoric. This was towards the close of the fifth century, after which we find no traces of the making or repairing of roads till recent times. The genius of the nations who completed the ruin of the Roman empire was wholly destructive; they repaired nothing; they destroyed every thing.

The money required for the construction and repair of roads was provided principally by the public, either by taking it directly from the treasury, or by local taxes imposed for the purpose, and in a few cases by individuals at their own expense. We cannot however much praise the liberality of emperors who executed works with what they called *sua pecunia*, but which was in fact drawn by them from the purses of the people. Julius Cæsar and Agrippa laid out their own money in repairing roads, as already noticed; and occasional instances of similar liberality on the part of individuals have been recorded. Apuleius, curator of roads, made ten miles of paved road, we know not where, at his own expense —

L. APVLEIVS.

* * * * *

CVRATOR. VIARVM.

STERNENDARVM.

PEDVM. DECEM.

MILLIA. VIAM.

SVA. PECVNIA.

FECIT.*

* Panvinio. Urbs Roma, p. 68.

A physician of the name of Publius Decimus Erotes, a freedman of Publius, gave 307,000 sesterees for the repair of roads; and cities or communities occasionally paid for and dedicated to the reigning emperor a road or a bridge. A road near Falisci was made by the Magistri Augustales, and dedicated to Augustus, and the great bridge at Alcantara, in Spain, was built by a certain C. Julius Lacerus, in honour of Trajan.* But private liberality or ostentation could contribute a very small part of the funds required for the roads of the Roman Empire.

We have a distinct account of how this matter was arranged in an ancient writer on rural affairs, Siculus Flaccus. He tells us, that the great public roads were made at the public charge, and named after the makers, and were under the care of curators, and repaired by contractors (*redemptores*), to pay whom a certain sum was from time to time levied from the proprietors. But the local roads (*viæ vicinales*), or as we would term them, commutation or parish roads, which pass through the country, and often lead from one great road to another, are kept up in a different manner —that is, by the *Magistri Pagorum*, public officers, for whom we have no equivalent English term, but as to this particular branch of their duties, the word may be fairly rendered Road Trustees. They exacted *work* from the proprietors to keep their roads in repair, or assigned to them a certain length of road, to be maintained at their expense.†

* Gruteri Inscript., p. 162.

† "Nam sunt viæ publicæ regalesque, quæ publicè muniuntur et auctorum nomina obtinent; nam et curatores accipiunt et per redemptores muniuntur in quarundam tutelam a possessoribus per tempus summa certa exigitur, vicinales autem viæ de publicis, quæ divertuntur in agros, et sæpe ad alteras publicas perveniunt, aliter muniuntur per pagos, ideo per magistros pagorum qui operas a possessoribus ad

The system thus applied to keep up local roads is almost identical with our old statute labour. Latterly, proprietors seem to have rather tired of paying their rates, and very stringent laws were enacted to constrain them to punctuality; and there was no exemption from these road taxes, for, by a law of Valentinian, the property of those who failed to pay was forfeited to the Crown; and by another of Honorius, it is declared, that no rank of persons, and not even churches and other sacred edifices, shall be exempted from the necessary tax.*

The rate payers were, however, protected against overcharges, as appears from an incidental notice in Capitolinus' life of M. Antoninus, where it is stated, that the Emperor empowered the curators of the regions and streets either to punish, or remit to the prefect of the city to punish those who had exacted more than the rate from any one.† The modern plan of making those who use a road pay for its maintenance by means of turnpike gates does not appear to have occurred to the ancient Romans.

We possess original accounts of the Roman mode of constructing roads from two very different sources — the one from the architect Vitruvius, and the other from the poet Statius.

The architect gives us clear and distinct specifications, which no contractor could mistake; while the poet describes

eas tuendas exigere soliti sunt, ut, aut comperimus unicuique possessori per singulos agros certa spatia assignantur quæ suis impensis tuentur." — Siculus Flaccus de Conditio Agr., p. 9.

* Codex Theodos., Lib. xv. tit. 3 and 6.

† "Ut vel puniunt, vel ad præfectum puniendos remitterent eos qui ultra vectigalia quidquam ab aliquo exegissent." — Capitol. in M. Antonino, c. xi.

the busy scene so vividly, that we cannot fail to realize it in all its details.

The passage of Vitruvius to which we refer, is the first chapter of his seventh book, which is entitled "De Ruderationibus."

I know no English word which exactly translates the Latin *ruderatio*. It means, as sufficiently appears from the description given, the placing of materials of all sorts, so as to prepare a solid and secure resting place for the superincumbent structure, whether that might be the wall of a house, a floor, a pavement, or a roadway.

The object of Vitruvius in writing the chapter evidently is, to give rules for Ruderatio, without regard to the structure which was to be raised upon it, only distinguishing in one part betwixt out-of-door and in-door work; and it might be read without being aware of its application to road making, did not the remains of ancient viæ show us, that their lower strata are formed precisely in the manner he prescribes; and his specifications for each part of the work are so distinct, that they might be carried into execution without difficulty at the present day.

The poet, on the other hand, describes the actual progress of the work, and perhaps we shall give the best idea of the whole by combining the two descriptions.

Statius is describing the construction of the Via Domitiana, a branch of the Appian, leading from Sinuessa to Pozzuoli, along the coast; he was the friend of that emperor, and devotes the third chapter of the fourth book of his "Silvae" to this subject. He first contrasts the state of the Via before and after the execution of the works, almost as we might now compare a rough cross road with a well-made railway —

"Hic quondam piger axe vectus in uno
Nutabat cruce pendula viator
Sorbebatque rotas maligna tellus
Et plebs in mediis Latina Campis
Horrebat mala navigationis.
* * * * * * *
* * * * * * *
At nunc, quæ solidum diem terebat
Horarum via facta vix duarum,
Non tensæ volucrum per astra pennæ
Nec velociùs ibitis carinæ."

A modern express train barely rivals the "tensæ voluerum pennæ" of the ancient poet.

The general mode of proceeding, both as enjoined by Vitruvius, and as described by Statius, was the following — The road was lined out as straight as possible, and the width marked by a trench at each side —

"Hic primus labor inchoare sulcos."

The next step was to remove the whole of the soil betwixt the trenches to the full depth of the road —

"———————— Et alto
Egestu penitus cavare terras."

If the ground at the bottom was found to be firm and solid, the surface of it was levelled, and the work proceeded — "quæratur solum si sit perpetuo solidum et ita exæquatur;" but if not, then piles were driven to secure it — "si autem omnis aut ex parte congestitius locus fuerit *fistucationibus* eum magna cura solidetur."

Thus a place was prepared to receive the mass of materials which formed the body of the road; this was termed the *gremium*, and the whole purpose of it was to prepare a suitable and durable bed for the upper surface — the pavimentum or roadway.

The gremium consisted of three distinct parts — the lowest being the *statumen*, the middle the *rudus*, and the uppermost the *nucleus*.

The statumen varied in depth according to circumstances. It was laid upon the surface of the bed of the road, whether the natural soil or the tops of the piles, and was composed of rough hard stones, not one of which was to be smaller than to fill the hand — "tunc statuminetur ne minore saxo quam quod possit manum implere." (Vitr. *ut sup.*) The ordinary depth, as seen in sections, seems to have been from twelve to eighteen inches.

On the statumen was placed the rudus, a mass of small broken stones mixed with lime mortar, thoroughly beat together and smoothed, and when finished not less than nine inches thick.

Isidorus thus explains what the rudus was — "Workmen call broken stones mixed with lime poured over them in constructing pavements, the rudus."*

Vitruvius gives distinct directions for preparing and finishing it.

The lime mortar was to be in the proportion of one-third if the materials were new, and of two-fifths if they were old. And after it was laid on, it was levelled and thoroughly beat together by parties of ten men, with heavy wooden mallets, till brought to the thickness of nine inches, and levelled.†

* "Rudus artifices appellant lapides contusos, et calci admixtos quos in pavimentis faciendis super fundunt, unde et rudera appellantur." — (Lib. VI. c. iii., Orig.)

† "Statuminibus inductis ruderetur. Rudus si novum erit, ad tres partes una calcis misceatur, si redivivum fuerit, quinque ad duum mixtiones habeant responsum. Deinde rudus inducatur, et vectibus ligneis, decuriis inductis, crebiter pinsatione solidetur, et id pinsum absolutum non minus crassitudine sit dodrantis." — (Vitruv. vii. 1.)

Above the rudus came the nucleus. It was a layer of broken bricks, tiles, and pottery, with the addition of a third part of lime mortar, and having, when finished, a depth of six inches.*

Such were the careful preparations to form a suitable bed for the roadway.

The roadway itself, in the best roads, was formed of blocks of basalt, the ancient silex (and modern selce), carefully laid by rule and level.†

These blocks were of various sizes, but usually from nine to twelve inches deep, and the sides cut into polygons, and so closely fitted together, that a newly made road appeared to be of one stone. This most durable material occurs in many parts of the Campagna, as noticed in a former paper.

On each side of a complete road was a footpath raised above the level of the roadway, sometimes paved like the road, sometimes only covered with gravel (glareâ), but in either case having a carefully placed margin of stones, termed *Gomphi.*

The centre of the roadway, the agger, stood higher than the sides, in order that the water might easily flow from it; and to it Virgil alludes in writing —

" Qualis sæpe viæ deprensus in aggere serpens."—(Æneid, v. 273.)

The accompanying section will assist in understanding the description now given.

After this dry detail of the specifications, let us take the poet's account of the work —

* " Insuper ex testa nucleus inducatur, mixturam habens ad tres partes unam calcis, uti ne minore sit crassitudine pavimentum digitorum senum." — (Vitruv. *ut supra.*)

† " Supra nucleum ad regulam et libellam exacta pavimenta struantur." — (Vitr. vii. 1.)

"Quid duri silicis gravisque ferri
Immanis sonus, æquori propinquum
Saxosæ latus Appiæ replevit?
* * * *
* * * *
Hic primus labor inchoare sulcos
Et rescindere limites et alto
Egestu penitus cavare terras
Mox haustas aliter replere fossas
Et summo gremium parare dorso,
Ne nutent sola, ne maligna sedes
Et pressis dubium cubile saxis.
Tunc umbonibus hinc et hinc, coactis
Et crebris iter alligare gomphis
O quantæ pariter manus laborant!
Hi cœdunt nemus, exuuntque montes:
Hi ferro scopulos, trabesque cædunt
Illi saxa ligant, opusque texunt
Cocto pulvere, sordidoque topho:
Hi siccant bibulas manu lacunas
Et longe fluvios agunt minores."*

It is very obvious, that roads constructed as now described, must have been most durable; and Vitruvius concludes his chapter by asserting, that when the foundations have been thus made, they will not soon go out of repair.†

Doubtless in the present day, the first cost of such roads would be very great; and yet it might be worth while to try the experiment in one of the crowded thoroughfares of our great cities, and ascertain whether it might not eventually be true economy to take a lesson in the matter from the ancient Romans.

* Stat. Sylvæ, iv. 3, line 1–3, and 40–55.

† "Cum sic erunt facta, non cito vitiabuntur."—Lib. vii. cap. 1, in fine.

The two great principles of their road making were a solid foundation and perfect dryness; and both these were obtained by the rules prescribed in the most effectual manner.

In planning a line of road, their great desire was to have it as level and as direct as possible. They seem to have regarded the line betwixt two stations as a distinct road, and were careful to keep it straight,* and the necessary angles were made at the stations. A glance at the Carta Pentingeriana, as well as many of the remains, prove this.

Only the principal roads had the pavement of *basalt.* Most of them had the gremium constructed according to rule, and a covering of gravel laid upon it instead of pavement,† which must have produced a road similar, but in some respects superior, to the best modern Macadamized turnpike.

An edict is quoted by Livy (A.U.C. 580), ordering that the streets of the city should be paved with basalt, and the roads in the country covered with gravel, from which it is clear, that the Appian Way alone had then been paved.‡

The width of the great roads seems to have varied from about sixteen feet, the width of the Via Prænestina, near Palæstrina, to twenty-six feet, the width of the Via Appia, in the Pontine marshes, and at one part near the tomb of Cecilia Metella; but it was not uniform on the same road. The side pavement of the Prænestina still remaining is little more than two feet wide. The twenty-six feet of the Appia must appear to us very narrow for

* Plutarch thus describes the works of Gracchus—Εὐθειας γαρ ηγοντο δια των χωριων ατρεμεις.—Plut. in V. C. Gracchi, c. 7.

† "Και το μεν εσορνυτο πετρα ξεστη, το δε αμμου χωμασι συνναχτοις επυκνουτο."—Plut. C. Gracchi, c. 7.

‡ "Vias sternendas silice in urbe, et glarea extra urbem substernendas."—Livy. Lib. xli. c. 32.

the principal approaeh to the eapital of the known world; but we must remember, that the wheel earriages of the ancients were much smaller than our own. The roads, too, by their number, in some measure eompensated for their narrowness; and the Tiber must have been the great highway from the distant provinees for heavy and bulky commodities. The eross roads appear to have been only eight feet wide.

We have mentioned the three Itineraries as the great sourees of our knowledge respeeting the lines of Roman roads. Unfortunately they differ so widely from each other in the distances, and even names of stations, that it is now probably impossible to aseertain the number of miles to which they extended. It must have been altogether very great; for a tolerably eorreet eomputation gives no less than 2500 miles in the distant provinee of Britain alone.

There was not long sinee an exeellent seetion of the Via Latina, whieh displayed its whole strueture, exposed by modern operations, about half way betwixt S. Cesareo and the Porta Latina; and another seetion near the Colosseum, showed, that in later times the emperors sometimes saerifieed substanee to show; for the basalt pavimentum was there, plaeed upon the rudus, but the other parts of the gremium, the nueleus, and the statumen, were awanting.

Many exeellent arrangements were made to facilitate travelling. If the towns were distant from eaeh other, posting stations (Mutationes) were established betwixt them, where post horses were kept always in readiness. The term is of perpetual oeeurrence throughout the Itineraries. At eaeh forty horses (Veredi) and postilions (Veredarii) were maintained for the publie serviee.*

* Many laws regarding them will be found in the Codex, Lib. xii. tit. 51.

We have not much information as to the speed of travelling in ancient times; but Pliny happens to have recorded one example, when the emperor Tiberius, travelling to visit his brother Drusus, who was sick in Germany, accomplished 200 miles in twenty-four hours.* This would be about eight miles an hour, a moderate rate in our days, but probably unattainable by common travellers in the reign of Tiberius. Gibbon quotes from Libanius the fact of a magistrate travelling from Antioch to Constantinople, 685 miles in five days and a half, in the reign of Theodosius, in the fourth century, being at the rate of 124½ miles in twenty-four hours. We shall not probably err greatly if we regard 100 miles a day as the utmost speed to be attained in ordinary circumstances.

Every thing regarding the use of roads was strictly regulated by law. The carriage most employed was the biga or birota, a very narrow vehicle, if we may judge both from the load it was permitted to carry, viz.—200 pounds, and from a marble model preserved in the Vatican Museum, or from the curious vignette given by Pratilli in his folio on the Appian Way.

"A rheda might carry 1000 pounds; a carrus be charged with 600 pounds; a carpentum was a more ancient vehicle, and carried 1000 pounds; but it could contain only two, or at most three persons. The anagariæ carried 1500 pounds. . . . . A rheda had eight mules in summer and ten in winter, and a birota three mules."†

Milestones were first erected by the tribune Caius Gracchus, at distances of 1000 double paces of five feet

* "Nocte ac die longissimum iter vehiculis tribus Tiberium Neronem emensum, festinantem ad Drusum fratrem ægrotantem in Germania, in eo fuerunt cc. Mille Passus." — Pliny Hist. Nat., Lib. viii. c. 20.

† Gell's Rome, i. 130.

eaeh ; therefore, if the standard foot be the same, the Roman mile of 5000 feet is less than the English of 1760 yards, or 5280 feet, by 280 feet, or $93\frac{1}{3}$ yards.

On eaeh side of the road, at distances of 40 yards, were plaeed low eolumns or seats, either for repose, or to assist in mounting on horsebaek ; and these were often adorned by statues of the Lares Viales, viz.—Mereury, Apollo, Baechus, Ceres, Diana, Janus, Jana, and Hereules.*

The Via Appia merits our speeial notiee, as being the most esteemed by the Romans, who termed it the Queen of Roads, " Regina Viarum ;" and the traveller who follows its eourse will, even now, find abundant examples of all the various aneient road operations.

We have, on a previous occasion, noticed the tombs and other ruins whieh stand on either side, and we now confine our remarks to the roadway itself.

The Christian regards it with lively interest, as the road along whieh the apostle Paul travelled a prisoner to Rome ; and two of its stations are named in the twenty-eighth chapter of the Acts of the Apostles, viz.—Appii Forum, and the Three Taverns, where the brethren from Rome met the great Apostle of the Gentiles, " whom, when Paul saw, he thanked God and took eourage."

These stations still retain their names — the Three Taverns being about thirty-three miles from Rome, and Appii Forum eighteen miles farther ; and it is highly probable that they have not moved far, if at all, from their ancient sites.

To the elassieal seholar the Appian Way is full of interest, from the numerous passages which name or allude to it. Every one remembers Horace's amusing account of his

* Gell's Rome, i. p. 129.

journey from Rome to Brundusium,* and the various pleasures and discomforts he encountered on his way. The indifferent fare, the noxious water, the noisy frogs, and the mali culices, have kept their ground to the present day, quite as securely as the ancient pavement.

The Via Appia was begun, according to Livy, in the year of Rome 442, by the censor Appius Claudius, from Rome to Capua, a distance of 1000 stadia or 125 miles. Festus and Frontinus give the same account. The latter says—"Appius Censor Viam Appiam a porta Capena usque Capuam munivit."† This was an extraordinary undertaking for a state so small, and so surrounded by enemies as Rome then was. It had subdued only a portion of Italy; for two years after (A. U. C. 446) we find Fabricius warring with the Tuscans in the recesses of the Cimenian Forest, not more than thirty or forty miles from Rome; and it was not till forty years later (viz. A. U. C. 481), that the Samnite war came to a close.

It issued from the Porta Capena, apparently so named from the adjoining temple of the Camænæ, corrupted to Capenæ, and not from Capua, to which the road conducted, nor from the ancient city of Capenæ, the firm ally of Veii, lying on the opposite side of Rome, on the summit of an ancient volcano, a few miles from Mount Soracte.‡

From Rome to Aricia, sixteen Roman miles, there was no great difficulty in the work; an occasional slight cutting or embankment kept the Via sufficiently level, the only important ascent being near Albano; but at Aricia there occurred a deep ravine, which was embanked in a most substantial manner. The embankment is altogether about 500 feet in length, and at the deepest thirty-three feet high, diminishing to three feet at each end.

* Hor. Sat. i. 5.

† Frontinus de aquæduct, c. 5.

‡ Gell's Rome, i. 264.

It is formed of rows of large stones, the horizontal divisions being in regular courses; but the *perpendicular* divisions are irregular, only that there are usually alternate rows of long and short stones, as was the custom both of the Romans and of the Etruscans.

At the deepest part there are twenty-four courses of ponderous blocks, and the masonry has a singular effect, from the difference betwixt the several courses, one being smooth, the next highly rusticated, the next less so; then one with projecting round knobs (the bugni of Italian architects), and then one quite smooth. I have met with no explanation of this singular caprice.

There are three small arches, apparently for the passage of water in time of floods. The interior work is rubble, and the contents of the whole about 234,000 cubic feet.

From Aricia the Appian Way passes through Genzano, close to the Lago di Nemi, the ancient Speculum Dianæ, and one of the loveliest spots in Italy; for several miles the ground is hilly, and the road is neither level nor straight, and there are several small embankments. From a point two or three miles beyond Genzano, the Via Appia takes a perfectly straight course to Terracina, nearly forty Roman miles distant.

The modern post road from Rome to Naples deviates much from the ancient until it reaches the Pontine Marshes. It issues from a different gate (the Porta San Giovanni), and, after repeatedly approaching, it first joins the old line at Fratocchie, about twelve miles from Rome. Passing Albano and Aricia they occasionally coincide, but from Genzano the modern diverges greatly to reach the town of Velletri, and it does not return to the Via Appia till a short distance south of the station of the Three Taverns. Here the celebrated Pontine Marshes commence, and here must

have been the most difficult and the most costly part of the work of Claudius, although it is now impossible to examine its construction. Across this level tract a mound is raised (five or six feet generally) above the surrounding plain, with a wide ditch on one side from the Three Taverns to the Apii Forum, and one on each side from thence to Terracina.

This part of the road has been often repaired, and indeed without constant attention, it would soon become impassable, as was the case for a long period during the middle ages, and again about the end of last century. It is said that on occasion of some recent repairs, three different ancient pavements were discovered, one above the other, at certain parts of the road, caused of course by the sinking of the foundation.

The Pontine Marshes are a dreary level, covering about 1000 square miles. Emperors and Popes have tried in vain for two thousand years to lay them dry. Where cultivated, they produce abundant crops, but they are mostly covered by the richest pasture. Horses, cattle, and swine thrive well upon them; man alone perishes.

The road from Tres Tabernæ to Terracina is intolerably monotonous after once or twice traversing it; the only variety is in the distant views of the Volscian and Ausonian mountains on the left, and of the forests which run along the sea coast, the representatives of the ancient Silvæ Laurentinæ, on the right.

We cannot doubt, that all this long embankment was made in the most careful manner; for it continued, with occasional repairs, to be in use from the days of Claudius down to the seventh or eighth century, if not longer, and after restorations at various epochs is now again doing its original work.

The following are the stations given from Rome to Terraeina in the Itinerary of Antoninus—

Arieia . . .	mille passus XVI.
Tribus Tabernis . . .	XVII.
Appii Forum	XVIII.
Terraeina	XVIII.
	LXIX.

At Terraeina the mountain was eut down 120 feet, and a similar work was required at Fondi, thirteen miles distant. After this there was no partieular difficulty in the line, except in passing the Minturnian Marshes, where the fistueationes would be very neeessary. About a mile from Sant' Agata there is a very singular old bridge—the Ponte Ronaeo —above 300 yards long, erossing a valley in whieh flows a small stream. Its peeuliarity eonsists in its departure from the level, in general so earefully preserved, and that without any apparent reason. First the roadway rises, then it falls, then a level, then another rise and fall land it on the opposite bank. The aneient pavement still remains upon it; the piers are partly of briek laterizia, and partly of opus ineertum, or rubble work of small stones with a large quantity of mortar; and a great number of the arehes are now eonverted into houses and eattle sheds. The highest points of the roadway are about twenty feet above the level of the ground.

Although unquestionably a part of the Via Appia, we can hardly suppose this structure to be of the time of Appius Claudius, and yet it has a very aneient appearanee.

From Sant' Agata to Capua, about fifteen miles, no great difficulty oeeurred; the entire length from Rome to the termination was 1000 stadia or 125 miles.

From this brief outline of the works on the Via Appia, it is no matter of surprise, that in their execution the treasury of Rome was exhausted in the year U. C. 442; it is unfortunate that we have no means of ascertaining the time, or the number of men required to complete the whole.

We have an excellent description of it as it existed in the sixth century, 900 years after its formation, from the pen of Procopius —

"To traverse the Appian Way is a distance of five days' journey for an active traveller, and it leads from Rome to Capua. Its breadth is such, that two chariots may meet upon it and pass each other without interruption; and its magnificence surpasses that of all other roads.

"For the construction of this great work, Appius caused the materials to be brought from a great distance, so as to have all the stones hard and of the nature of millstones, such as are not to be found in this part of the country.* Having ordered this material to be smoothed and polished, the stones were cut in corresponding angles, so as to fit together without the insertion of metal or any other substance. And thus they are so firmly combined, that one looking at them would say they were not put together artificially, but had grown so on the spot; and after the wear and tear of so many ages, traversed daily by a multitude of vehicles and all sorts of animals, they still remain unmoved, nor can the least trace of injury or waste be observed on them, nor have they lost aught of their beautiful polish. Such is the Via Appia."†

Twelve centuries have elapsed since Procopius wrote, and yet his description is applicable to this day to those portions of the road which can be traced.

* This is a mistake; many quarries of basalt occur in the Campagna.

† Procop. de Bello Gothico, i. 14.

The Via Appia may be regarded as a type or model of the best Roman roads. All the others were executed in a similar manner, but with such alterations as circumstances required.

About nine miles from Rome, on the Via Labicana, is a beautiful example of a bridge — the Ponte di Nono — of eight arches, built for the sole purpose of maintaining the level of the roadway. The middle arches are fully thirty feet high, and a paltry rivulet passes under one of them. The date is unknown, but it has all the appearance of being of the time of the Republic, and is now as entire as when it was erected, unless it had parapet walls, of which doubtful traces exist on the edges of the masonry. The pavement of basalt remains; the arches are built of the hard peperine of Gabii from the adjacent quarries, and the wing walls of the hard red tufo found also in the neighbourhood. The masonry is *opus quadratum*, very slightly rusticated.

Tunnelling was not unknown to the Romans, though very rarely practised. The principal example is the celebrated grotto of Posilippo, forming a continuation of the Via Domiziana from Pozzuoli (Puteoli) to Naples. It was excavated by Cocceius, in the reign of Augustus.* The nature of the rock made it a comparatively easy process; it is a mass of indurated volcanic ashes, sufficiently tenacious to be tunnelled with safety to the workmen, and yet soft enough to be very easily cut; but the extent of the work is very considerable.

Strabo describes it as a *covered ditch* in the mountain betwixt Pozzuoli and Naples, sufficiently wide to allow two chariots to pass each other, and many stadia long; and that

* Strabo, Lib. v. p. 169.

light was admitted by holes carried up to the top of the mountain.*

Seneca gives a deplorable account of its condition in one of his letters—"Nothing longer than this prison, nothing darker than its jaws, which makes us not to see in the dark, but the darkness itself—even if the place had light, the dust would take it away."†

The actual length is not many stadia, but about 360 yards. It was paved with basalt by Domitian, but has been levelled and repaired in modern times.

Another small tunnel in the same district, leading from the Lacus Avernus to Baiæ, is shown to travellers as the Cumean Sybil's Cave or Grotto. Its date is unknown, and these are only noticed here to show that the art of tunnelling was not wholly unknown to the Romans.

If we view the roads of the Romans as executed during the Republic, we must regard them as stupendous, whether in respect to the extent, the population, or the wealth of the country.

If we consider them as accomplished during the Empire, they are, by their extent, and their solidity, and their usefulness, well worthy of all the greatness of the Mistress of the World.

If, again, we compare them with the modern works of our own island, a petty province of Old Rome, we shall find no reason to be ashamed of ourselves. The embankments,

* "Εστι δε και ενθαδε διωρυξ κρυπτη του μεταξυ ορους - - - - - - οδου τε ανοιχθεισης εναντιοις ξευγεσι πορευτης επι πολλους σταδιους· τα δε φωτα εκ της επιφανειας του ορους πολλαχοθεν εκκοπεισων θυριδων δια βαθους πολλου καταγεται." Strabo. Lib. v. p. 377.

† "Nihil illo carcere longius, nihil illis faucibus obscurius, quæ nobis præstant non ut per tenebras videamus, sed ut ipsas. Cæterum etiam si locus haberet lucem, pulvis auferret." Senecæ, Epist. lvii.

and tunnels, and the viaducts of Britain, infinitely surpass in labour, in cost, and in utility, the whole combined roads of the Roman Empire — probably more wealth and more persons travel by them in a week than were seen upon the roads of the Imperium Romanum in a year.

The Roman roads carried wealth and civilization, as then existing, throughout the Empire; the modern system of railways promises fair to reunite ere long the various nations of the earth in one common brotherhood of intercourse and friendship, and to be one means of assisting to banish national quarrels, and their consequent bloodshed and violence, from our world.

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No. V.

ON THE PRESENT STATE OF THE ART OF DESIGN AS CONNECTED WITH SCIENCE.

BY

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[*Read at a Meeting of the Institute on 8th March*, 1855.]

When I had the honour to be applied to a few days ago for something to lay before this meeting of the Institute, the only subject I had in readiness, which I thought might be interesting, was an exhibition and explanation of the illustrations which had accompanied two papers read to the Royal Institute of British Architects in London. On second thought, however, it occurred to me, that the acceptance by the Council of this second-hand subject was an act of condescension towards me which called for some more adequate response. I therefore propose to read before the meeting an original essay on the present state of the Fine Arts as connected with Science, prepared as the Introduction to a work upon which I am at present engaged. I considered this essay the more appropriate, as architecture is the most

purely scientific of the fine arts, not being of an imitative character, but depending for its beauty upon the arrangement and proportion of abstract forms.

It is now more than ten years since one of our most eminent philosophers, Sir David Brewster, assured us, through the medium of the Edinburgh Review,* that art would not sufficiently develop her powers, nor science attain her most commanding position, till the practical knowledge of the one is taken for the sound deductions of the other; in short, until a species of exchange should exist between the practical impulses of genius and the recognized fountains of scientific knowledge; that although, in the then advanced state of the mechanical and useful arts, the causes which had concurred to place art and science at variance had almost wholly disappeared, yet in the fine arts, and in the speculations with which they are associated, the controlling power of scientific truth had not exercised its legitimate influence. For, in discussing the principles of painting, sculpture, and architecture, science had been renounced as a guide, and even as an auxiliary; and a school had arisen whose speculations would brook no restraint, and whose decisions stood in opposition to the strongest conviction of our senses, and proceeds to remark—"That the external world, in its gay colours and lovely forms, is exhibited to the mind only as a tinted mass, neither within nor without the eye, neither touching it nor distant from it—an ubiquitous chaos, which experience only can analyze and transform into the realities which compose it; that the beautiful and sublime in nature and in art derive their power over the mind from association alone, were among the doctrines of the philosophy of the day, which, if it were safe, it were scarcely prudent to question." These doctrines, he observed, had

* No. CLVIII. October, 1843.

been given to the world with all the authority of demonstrated truth; and in proportion to the hold which they had taken of the public mind, had they operated as a check upon the progress of knowledge; for while such theories of taste prevailed, there could be no inducement to examine the laws of harmony, or to investigate the origin of beautiful forms by developing the laws of regular and irregular symmetry.

Such then was the state of art as connected with science ten years ago. But although the causes which then placed science and fine arts at variance have since in some measure diminished, yet they are still far from being removed. In proof of this I may refer to what took place at the last annual distribution of the prizes to the students attending our Scottish Metropolitan School of Design, the pupils in which now amount to upwards of two hundred. The meeting on this occasion included, besides the pupils, a numerous and highly respectable assemblage of artists and men of science. The chairman, a Professor in our University, and editor of one of the most voluminous works on art, science, and literature, ever produced in this country, after extolling the general progress of the pupils, so far as evinced by the drawings exhibited on the occasion, then drew the attention of the meeting to a discovery made by the head master of the architectural and ornamental department of the school, viz.— That the ground plan of the Parthenon at Athens had been constructed by the application of the *mysterious* ovoid or *Vesica Piscis* of the middle ages, subdivided by the *mythic* numbers 3 and 7, and their intermediate odd number 5. Now, I beg to remark, that the figure thus referred to is not an ovoid, neither is it in any way of a mysterious nature, being produced simply by two equal circles cutting each other in their centres. Neither can it be shown that the numbers 3 and 7 are in any way more mythic than other

numbers. In fact, the terms *mysterious* and *mythic* so applied, can only be regarded as a remnant of ancient quackery, calculated to obscure the simplicity of scientific truth, and when used by those employed to teach—for doubtless the chairman only gave the description he received—must tend to retard the connection of that truth with the arts of design. I shall now give a specimen of the manner in which a knowledge of the philosophy of the fine arts is at present inculcated upon the public mind generally. In the same metropolis there has likewise existed for nearly ten years a Philosophical Institution of great importance and utility, whose members amount to nearly three thousand, embracing a large proportion of the higher classes of society, both in respect to talent and wealth. At the close of the last session of this Institution, a learned and eloquent philologus, who occasionally lectures upon beauty, was appointed to deliver the closing address, and touching upon the subject of the beautiful, he thus concludes —

"In the worship of the beautiful, and in that alone, we are inferior to the Greeks. Let us therefore be glad to borrow from them; not slavishly, but with a wise adaptation —not exclusively, but with a cunning selection; in art, as in religion, let us learn to prove all things, and hold fast that which is good — not merely one thing which is good, but all good things — Classicalism, Mediævalism, Modernism — let us have and hold them all in one wide and lusty embrace. Why should the world of art be more narrow, more monotonous, than the world of nature? Did God make all the flowers of one pattern to please the devotees of the rose or the lily; and did he make all the hills, with the green folds of their queenly mantles, all at one slope to suit the angleometer of the most mathematical of decorators? I trow not. Let us go and do likewise."

I here take for granted, that what the lecturer means by "the worship of the beautiful," is the production and appreciation of works of art in which beauty should be a primary element; and judging from the remains which we possess of such works as were produced by the ancient Grecians, our inferiority to them in these respects cannot certainly be denied. But I must reiterate what I have often before asserted, that it is not by borrowing from them, however cunning our selection, or however wise our adaptations, that this inferiority is to be removed, but by a rediscovery of the science which these ancient artists must have employed in the production of that symmetrical beauty and chaste elegance which pervaded all their works for a period of nearly three hundred years. And I hold, that as in religion, so in art, there is only one truth, a grain of which is worth any amount of philological eloquence.

I also take for granted, that what is meant by Classicalism in the above quotation, is the ancient Grecian style of art; by Mediævalism the semi-barbaric style of the middle ages; and by Modernism that chaotic jumble of all previous styles and fashions of art, which is the peculiar characteristic of our present school, and which is doubtless the result of a system of education based upon plagiarism and mere imitation. Therefore a recommendation to embrace with equal fervour "as good things," these very opposite artic*isms* must be a doctrine as mischievous in art as it would be in religion to recommend as equally good things the various *isms* into which it has also been split in modern times.

Now, "the world of nature" and "the world of art" have not that equality of scope which this lecturer on beauty ascribes to them, but differ very decidedly in that particular. Neither will it be difficult to show why "the world of art *should* be more narrow than the world of nature"—that it

should be thereby rendered more monotonous does not follow.

It is well known, that the "world of nature" consists of productions, including objects of every degree of beauty from the very lowest to the highest, and calculated to suit not only the tastes arising from various degrees of intellect, but those arising from the natural instincts of the lower animals. On the other hand, "the world of art," being devoted to the gratification and improvement of intelligent minds only, is therefore narrowed in its scope by this exclusion from its productions of the lower degrees of beauty—even mediocrity is inadmissible; and we know that the science of the ancient Greek artists enabled them to excel the highest individual productions of nature in the perfection of symmetrical beauty. Consequently, all objects in nature are not equally well adapted for artistic study, and it therefore requires on the part of the artist, besides true genius, much experience and care to enable him to choose proper subjects from nature; and it is in the choice of such subjects, and not in plagiarism from the ancients, that he should select with knowledge and adapt with wisdom. Therefore all such latitudinarian doctrines as those I have quoted, must act as a check upon the progress of knowledge in the scientific truth of art. I have observed in some of my works, that in this country a course had been followed in our search for the true science of beauty not differing from that by which the alchymists of the middle ages conducted their investigations; for our ideas of visible beauty are still undefined, and our attempts to produce it in the various branches of art are left dependant, in a great measure, upon chance. Our schools are conducted without reference to any first principles or definite laws of beauty, and from the drawing of a simple architectural moulding to the intricate combinations of form in the human figure, the

pupils depend upon their hands and eyes alone, servilely and mechanically copying the works of the ancients, instead of being instructed in the unerring principles of science, upon which the beauty of those works normally depends. The instruction they receive is imparted without reference to the judgment or understanding, and they are thereby led to imitate effects without investigating causes. Doubtless, men of great genius sometimes arrive at excellence in the arts of design without a knowledge of the principles upon which beauty of form is based; but it should be kept in mind, that true genius always includes an intuitive perception of those principles along with its creative power. It is therefore to the generality of mankind, that instruction in the definite laws of beauty will be of most service, not only in improving the practice of those who follow the arts professionally, but in enabling all of us to distinguish the true from the false, and to exercise a sound and discriminating taste in forming our judgment upon artistic productions. Æsthetic culture should therefore supersede servile copying, as the basis of instruction in our schools of art. Many teachers of drawing, however, still assert, that by copying the great works of the ancients, the mind of the pupil will become imbued with ideas similar to theirs—that he will imbibe their feeling for the beautiful, and that, consequently, he will become inspired with their genius, and think as they thought. To study carefully and to investigate the principles which constitute the excellence of the works of the ancients, is no doubt of much benefit to the student; but it would be as unreasonable to suppose that he should become inspired with artistic genius by merely copying them, as it would be to imagine, that in literature poetic inspiration could be created by making boys transcribe or repeat the works of the ancient poets. Sir Joshua Reynolds

considered copying as a delusive kind of industry, and has observed, that "Nature herself is not to be too closely copied," asserting that "there are excellences in the art of painting beyond what is commonly called the imitation of nature," and that "a mere copier of nature can never produce any thing great." Proclus, an eminent philosopher and mathematician of the later Platonist school (A.D. 485), says, that "he who takes for his model such forms as nature produces, and confines himself to an exact imitation of these, will never attain to what is perfectly beautiful. For the works of nature are full of disproportion, and fall very short of the true standard of beauty."

It is remarked by Mr. J. C. Daniel, in the introduction to his translation of M. Victor Cousin's "Philosophy of the Beautiful," that "the English writers have advocated no theory which allows the beautiful to be universal and absolute; nor have they professedly founded their views on original and ultimate principles. Thus the doctrine of the English school has for the most part been, that beauty is mutable and special, and the inference that has been drawn from this teaching is, that all tastes are equally just, provided that each man speaks of what he feels." He then observes, that the German, and some of the French writers have thought far differently; for with them the beautiful is "simple, immutable, absolute, though its *forms* are manifold."

So far back as the year 1725, the same truths advanced by the modern German and French writers, and so eloquently illustrated by M. Cousin, were given to the world by Hutchison in his "Inquiry into the Original of our Ideas of Beauty and Virtue." This author says—"We, by absolute beauty, understand only that beauty which we perceive in objects, without comparison to any thing external,

of which the object is supposed an imitation or picture, such as the beauty perceived from the works of nature, artificial forms, figures, theorems. Comparative or relative beauty is that which we perceive in objects commonly considered as imitations or resemblances of something else."

Dr. Reid also, in his "Intellectual Powers of Man," says, "That taste, which we may call rational, is that part of our constitution by which we are made to receive pleasure from the contemplation of what we conceive to be excellent in its kind, the pleasure being annexed to this judgment, and regulated by it. This taste may be true or false, according as it is founded on a true or false judgment. And if it may be true or false, it must have first principles."

M. Victor Cousin's opinion upon this subject is, however, still more conclusive. He observes—"If the idea of the beautiful is not absolute, like the idea of the true—if it is nothing more than the expression of individual sentiment, the rebound of a changing sensation, or the result of each person's fancy—then the discussions on the fine arts waver without support, and will never end. For a theory of the fine arts to be possible, there must be something absolute in beauty, just as there must be something absolute in the idea of goodness, to render morals a possible science."

The basis of the science of beauty must thus be founded upon fixed principles, and when these principles are evolved with the same care which has characterized the labours of investigators in natural science, and are applied in the fine arts as the natural sciences have been in the useful arts, a solid foundation will then be laid not only for correct practice, but also for a just appreciation of productions in every branch of the arts of design.

We know that the mind receives pleasure through the sense of hearing, not only from the music of nature, but

from the euphony of prosaic composition, the rhythm of poetic measure, the artistic composition of successive harmony in simple melody, and the combined harmony of counterpoint in the more complex works of that art. We know, also, that the mind is similarly gratified through the sense of seeing, not only by the visible beauties of nature, but by those of art, whether in symmetrical or picturesque compositions of forms, or in harmonious arrangements of gay or sombre colouring.

Now, in respect to the first of these modes of sensation, we know, that from the time of Pythagoras, the fact has been established, that in whatever manner nature or art may address the ear, the degree of obedience paid to the fundamental law of harmony will determine the presence and degree of that beauty with which a perfect organ can impress a well-constituted mind; and it is my object in this, as it has been in former attempts, to prove it consistent with scientific truth, that that beauty which is addressed to the mind by objects of nature and art, through the eye, is similarly governed. In short, to show, that as in compositions of sounds there can be no true beauty in the absence of a strict obedience to this great law of nature, neither can there exist, in compositions of forms or colours, that principle of unity in variety which constitutes beauty, unless such compositions are governed by the same law.

Although in the songs of birds, the gurgling of brooks, the sighing of the gentle summer winds, and all the other beautiful music of nature, no analysis might be able to detect the operation of any precise system of harmony, yet the pleasure thus afforded to the human mind we know to arise from its responding to every development of an obedience to this law. When, in like manner, we find even in those compositions of forms and colours which constitute

the wildest and most rugged of Nature's scenery, a species of picturesque grandeur and beauty to which the mind as readily responds as to her more mild and pleasing aspects, or to her sweetest music — we may rest assured, that this beauty is simply another development of and response to the same harmonic law, although the precise nature of its operation may be too subtle to be easily detected.

I trust soon to be enabled, by a *resumè* of the various works I have already published upon the subject, along with additional demonstrations, to point out a system of harmony, which, in the formative arts, as well as in that of colour, will rise superior to the idiosyncracies of different artists, and bring back to one common type the sensations of the eye and the ear, thereby improving that knowledge of the laws of the universe which it is the business of science to connect with the ornamental as well as with the useful arts.

In attempting this, however, I beg it may be understood, that I do not believe any system, based even upon the laws of nature, capable of forming a royal road to the perfection of art, or of "mapping the mighty maze of a creative mind." At the same time, however, I must reiterate the fact, that the diffusion of a general knowledge of the science of visible beauty must afford latent artistic genius an important vantage ground — just such a vantage ground as that which the general knowledge of philology diffused throughout this country affords its latent literary genius. Although *mere learning* and *true genius* differ as much in the practice of art as they do in the practice of literature, yet a precise and systematic education in the true science of beauty must certainly be as useful in promoting the practice and appreciation of the one, as a precise and systematic education in the science of philology is in promoting the practice and appreciation of the other.

As all beauty is the result of harmony, it will be requisite here to remark, that harmony is not a simple quality, but as Aristotle defines it, "the union of contrary prineiples having a ratio to eaeh other." Harmony thus operates in the production of all that is beautiful in nature, whether in the combinations, in the motions, or in the affinities of the elements of matter.

The contrary principles to whieh Aristotle alludes, are those of uniformity and variety; for, aecording to the predominanee of the one or the other of these prineiples, every kind of beauty is eharacterized. Henee the differenee between symmetrieal and pieturesque beauty — the first allied to the prineiple of uniformity, in being based upon preeise laws that may be taught so as to enable men of ordinary capaeity to produee it in their works — the seeond allied to the prineiple of variety often to so great a degree that they yield an obedienee to the preeise principles of harmony so subtilely, that they eannot be detected in its eonstitution, but are only felt in the response by which true genius acknowledges their presenee. The generality of mankind may be capable of perceiving this latter kind of beauty, and of feeling its effeets upon the mind, but men of genius only ean impart it to works of art. Throughout the sounds, forms, and eolours of nature, these two kinds of beauty are found not only in distinet developments, but in every degree of amalgamation. We find in the songs of some birds, sueh as those of the ehaffineh, &e., a rhythmieal division, resembling in some measure the symmetrically preeise arrangements of parts which characterizes all artistie musieal composition; while in the songs of other birds, and in the other numerous melodies with whieh nature eharms and soothes the mind, there is no distinet regularity in the division of their parts. In the forms of nature, too, we find amongst the innumerable

flowers with which the surface of the earth is so profusely decorated, an almost endless variety of systematic arrangements of beautiful figures, often so perfectly symmetrical in their combination, that the most careful application of the angleometer could scarcely detect the slightest deviation from geometrical precision; while, amongst the masses of foliage by which the forms of many trees are divided and subdivided into parts, as also amongst the hills and valleys, the mountains and ravines, which divide the earth's surface, we find in every possible variety of aspect, the beauty produced by that irregular species of symmetry which characterizes the picturesque.

In like manner, we find in wild as well as cultivated flowers the most symmetrical distributions of colours accompanying an equally precise species of harmony in their various kinds of contrasts, often as mathematically regular as the geometric diagrams by which writers upon colour sometimes illustrate their works; while in the general colouring of the picturesque beauties of nature, there is an endless variety in its distributions, its blendings, and its modifications. In the forms and colouring of animals, too, the same endless variety of regular and irregular symmetry is to be found. But the highest degree of beauty in nature is the result of an equal balance of uniformity with variety. Of this the human figure is an example; because, when it is of those proportions universally acknowledged to be the most perfect, its uniformity bears to its variety an apparently equal ratio. The harmony of combination in the normal proportions of its parts, and the beautifully simple harmony of succession in the normal melody of its softly undulating outline, are the perfection of symmetrical beauty; while the innumerable changes upon the contour which arise from the actions and attitudes occasioned by the various emotions of the mind, are calculated to produce

every species of picturesque beauty, from the softest and most pleasing, to the grandest and most sublime.

Amongst the purely picturesque objects of inanimate nature, I may instance an ancient oak tree, for its beauty is enhanced by want of apparent symmetry. Thus, the more fantastically crooked its branches, and the greater the dissimilarity and variety it exhibits in its masses of foliage, the more beautiful it appears to the artist and the amateur; and, as in the human figure, any attempt to produce variety in the proportions of its lateral halves would be destructive of its symmetrical beauty, so in the oak tree, any attempt to produce palpable similarity between any of its opposite sides would equally deteriorate its picturesque beauty. But picturesque beauty is not the result of the total absence of symmetry; for, as none of the irregularly constructed music of nature could be pleasing to the ear unless there existed in the arrangement of its notes an obedience, however subtle, to the great harmonic law of Nature, so neither could any object be picturesquely beautiful, unless the arrangement of its parts yields, however obscurely, an obedience to the same law.

In short, as a variety of simultaneously produced sounds, which do not relate to each other agreeably to this law, can only convey to the mind a feeling of mere noise; so a variety of forms or colours simultaneously exposed to the eye under similar circumstances, can only convey to the mind a feeling of chaotic confusion, or what may be termed *visible* discord.

However symmetrically beautiful any architectural structure may be, when in a complete and perfect state, it must, as it proceeds towards ruin, blend the picturesque with the symmetrical; but the type of its beauty will continue to be the latter, so long as a sufficient portion of it remains to convey an idea of its original perfection. It is the same with the human form and countenance; for age does not destroy their

original beauty, but in both only lessens that which is symmetrical, while it increases that which is picturesque.

As Vitruvius says, " symmetry consists in the commensurability of the various constituent parts with the whole;" and as the two principles of uniformity and variety, or similarity and dissimilarity, are in operation in every harmonious combination of the elements of sound, of form, and of colour, we must first have recourse to numbers in the abstract before we can form a proper basis for a universal science of beauty. By such a process I intend to commence the *resumè* to which this short essay is merely an introduction.

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No. VI.

ON THE CHEMISTRY OF BUILDING MATERIALS.

BY

GEORGE WILSON, Esq., M.D., F.R.S.E.

THIRD OF SERIES.

"ON CALCAREOUS STONES."

[*Read at a Meeting of the Institute, held on 29th March*, 1855.]

The word "*Calcareous*" strictly signifies "of or belonging to Lime," and implies the presence and, in general, the predominance of that substance in the body to the title of which it is prefixed; but it has long been extended, both by theoretical and practical men, so as to include bodies containing magnesia as well as lime, and chemists embrace under the term "calcareous earths" both of these substances.

The English word "limestone" has a similar meaning. It signifies a stone which certainly contains lime, but may also contain magnesia; and as these earths occur in limestones united with carbonic acid, so as to form carbonate of lime and carbonate of magnesia, a calcareous building stone

or limestone may be defined to be a stone consisting in greater part of carbonate of lime, or of carbonate of lime and carbonate of magnesia. This definition has reference solely to the chemical composition of limestones, but their physical structure is of equal importance in estimating their architectural value.

Considered chemically, the calcareous building stones may be divided into three groups.

I. *Simple Limestones* or *Limestones Proper*, consisting of carbonate of lime.

II. *Magnesian Limestones*, consisting of carbonate of lime and carbonate of magnesia.

III. *Composite Limestones*, containing, in addition to one or both of the calcareous carbonates, silica (sand), silicate of alumina (clay), oxide of iron, bitumen, phosphate of lime (bone-earth), and the like, and which are named according to the predominating additional ingredients, siliceous, argillaceous, clayey, bituminous, or phosphatic limestones.

In the preceding enumeration I have omitted those recent aqueous calcareous deposits, called by geologists *Calc-tuffs*, analogous to *stalactites* and *stalagmites*, because, though used in other countries as building materials, they are unknown as such in Great Britain. Many of the Roman edifices, alike ancient and modern, are constructed of such a stone, called *Travertino* or Travertine.

Simple limestones, so far as their application in building is concerned, may be divided into three classes.

1. Crystalline Limestones or Marbles.
2. Compact or Massive Limestones.
3. Oolitic Limestones or Roe-stones.

1. *Crystalline Limestones.*

Simple limestone is most perfectly represented by white statuary marble, such as that of Paros or Carrara. It may be regarded as chemically pure carbonate of lime, consisting of fifty-six per cent. of lime and forty-four per cent. of carbonic acid. Its structure is uniform and crystalline; the component crystals being very small, but closely adherent, so that it resembles loaf sugar, except that it is much less porous. The crystals are, in thin scales, transparent, and plates of marble of considerable thickness allow a certain amount of light to traverse them, and are indebted to its passage for a portion of the peculiar lustre, so devoid of opaque chalkiness which belongs to pure white marble. Its uniformity of structure allows it to be quarried in large blocks, and its comparative softness and crystalline texture to be easily chiselled, nor does any stone take a more uniform and beautiful polish.

The coloured marbles (properly so called) are all less pure than the white, the colouring matter being always some foreign body; but even where the tint is considerable, the amount of colouring matter is frequently very small, and except for the purposes of the sculptor, their good qualities are as marked as those of the white marble. In speaking thus, I exclude all the non-calcareous stones, which, in the language of artists, find a place among marbles, and all the calcareous aggregates of fossil shells and corals, which will be considered under the head of composite limestones.

2. *Compact or Massive Limestones.*

Under simple limestones, we must include substances less pure than statuary marble; nor in truth is it possible

to draw a line of sharp demarcation between them and the magnesian or the composite limestones. We must certainly refuse the title of limestone proper to any stone containing less than half its weight of lime, or less than ninety per cent. of carbonate of lime; but within those limits it may be justly enough applied, especially if no *single* ingredient makes up the per centage. Where small quantities of different bodies, such as water, bitumen, iron, alumina, and magnesia together, constitute five per cent. of a mass otherwise consisting of carbonate of lime, its suitability for building purposes is so substantially identical with that of the pure carbonate, that it may be included in the same category.

Marble, also, is rather an artist's than a chemist's or geologist's word, and may be applied to any limestone, which from its colour and susceptibility of polish, is thought worthy to become the vehicle of the sculptor's art; so that marbles and limestones shade away into each other, and do not admit of being placed apart in separate groups. What an Italian, for example, might refuse to call other than a limestone, an Englishman might honour with the name of native marble.

There is this distinction, however, between the marbles in their best examples and the limestones, simply so called, in theirs; that the marbles are crystalline, and therefore granular in structure, are easily wrought, and take a high polish; whilst the limestones are non-crystalline or imperfectly crystalline, are not granular but compact in structure, are harder and less easily wrought, and do not take a high polish; but the hardest limestone is much softer than any building sandstone, and is more enduring as a building material for outer walls in a climate like ours than a marble would be.

No stone is superior to limestone for building with, where the conditions of climate are suitable. In Great Britain, however, the finer crystalline limestones or marbles suffer rapidly if freely exposed. They are soluble to a minute yet appreciable extent in pure water, which their porosity allows readily to enter. They are still more soluble in water containing carbonic acid, such as rain water or melted snow; and in water containing the products of combustion, viz.—carbonic acid, sulphurous and sulphuric acid, which are added to rain when it falls within the precincts of large cities, and especially when it runs over the roofs or walls of houses. They are liable to be splintered in cold weather by the freezing of the water retained by their pores, and are readily stained by the substances which enter these, and by the growth of the green *confervae* which cover readily wet stones of all kinds. For sculpture, accordingly, to be exposed in all weathers, whether statuary or fine carving, they are unsuitable in climates like our own, from the deterioration in beauty, both of form and colour, which rapidly occurs; but for ordinary building purposes, the marbles, especially the darker ones, would be suitable enough; and the non-crystalline, or compact simple limestones, are extensively employed all over the world as building stones.

3. *Oolite or Roe-Stone Limestones.*

One of the most extensively employed limestones in England, throughout the eastern and midland counties, is named Oolite, literally *egg-stone*, from its peculiar structure. It consists of a multitude of small spherical grains, resembling in colour and appearance mustard-seed, and adhering together like the ova or eggs which constitute the roe of a fish; hence its English name of *Roe-stone*. The component particles vary in size from that of pin heads to that of small

peas; but when they exceed the latter size, the resulting mass is termed *Pisolite* or *Pea-stone*. The oolitic globules appear to have been formed by deposition of carbonate of lime from solution in water charged with carbonic acid. Agitation of the water in which they have been deposited prevented for a time the carbonate from falling quietly as a sediment, so that it gathered round separate nuclei, each of which became converted into a calcareous globule. These globules afterwards settled down to the bottom, and gathered together into a mass, ultimately consolidating into an oolite or roe-stone. The nucleus of each globule appears frequently to have been a crystalline grain of carbonate of lime, round which similar grains clustered, as we see a minute snow-flake attract others to itself, and become a large snow-feather — a spherical configuration not being attainable in the circumstances. Where the globules have been formed round particles of the same nature as themselves, they are solid, often radiated in structure, or simply compact; frequently they consist of consecutive layers covering each other, like the different coats of an onion. A stone consisting of such solid globules, adhering together without interposed cement, or only with a calcareous one of the same composition as themselves, affords the best building oolite, and may (as implied already) be as pure as the simple crystalline limestone. Such, for example, is the character of the oolite from Kelton in Rutlandshire, with which many of the public edifices in Cambridge, the modern portions of Peterborough and Ely Cathedrals, and some of the churches in London have been built.

In other cases, the component ovules of the oolite are hollow within, as if they had formed round a perishable nucleus, such as a particle of vegetable matter, or a grain of salt, which has afterwards been decomposed and washed

or dissolved away. Such hollow globules occur in the well-known Bath limestone, employed largely in that city and elsewhere — Buckingham Palace, London, among other edifices, being built of it. The same peculiarity of hollow ovules occurs to some extent in the most famous English oolite, the Portland stone, with which St. Paul's Cathedral and a host of other churches and edifices in the metropolis have been erected. When such ovules, by superficial disintegration, have their cavities laid open, these must afford a lodgment to water, dust, and smoke, and lead to the disfigurement and decay of the stone. Many oolites, accordingly, are found to give way very rapidly when exposed to atmospheric action, partly from this peculiarity, but also from the interposed cementing matter wearing at a different rate from the ovules themselves. Many limestones, in their general structure oolitic, contain also fragments of shells and non-calcareous matter. They thus approximate to the composite limestones, under which they will be referred to.

II. Magnesian Limestones.

The term Magnesian Limestone is applied to a compound of lime, magnesia, and carbonic acid, which occurs both in regular crystals, like those of Iceland Spar, and in rocky masses, forming whole mountains. The lime and magnesia are united with the carbonic acid as carbonate of lime and carbonate of magnesia, and as these can crystallize together in any relative proportion, different magnesian limestones contain very unlike quantities of their common ingredients. That variety, however, is considered the most typical and characteristic which contains the two carbonates united in equivalent proportions, *i. e.*, fifty parts of carbonate of lime to forty-two of carbonate of magnesia, and forty-four of carbonic acid.

More than half this variety, which nearly resembles in composition the Bolsover Limestone used in the construction of the Houses of Parliament, is thus carbonate of lime; and in all the varieties, it preponderates over the carbonate of magnesia. The majority of magnesian limestones contain, in addition, small quantities of iron, silica, alumina, and water, like the simple limestones.

The fact of a stone of the class we are considering having been preferred for the Houses of Parliament, shows the high esteem in which it is held in England. The Bolsover magnesian limestone contains about ten per cent. of foreign matter, of which about one half is silica, and the other half water. Its specific gravity in mass is 2316, and in powder 2833, both being higher than those of Craigleith stone, which stands at the head of our sandstones. Its cohesive power is 117; that of Craigleith stone 111. In structure it is semi-crystalline, and it is little altered by the atmosphere.

Throughout England, and especially in Yorkshire, many buildings exist constructed of magnesian limestone from different quarries. Some of those edifices date from the twelfth, thirteenth, and fourteenth centuries, such as Beverley Minster, Knaresborough Castle, Roche Abbey, Spofforth Castle, and are still, in great part, in good condition, and in some cases in perfect preservation. It is not surprising, therefore, that the reporters on the stones most suitable for the Houses of Parliament should have given the preference to magnesian limestone, not only for them, but for all edifices. They are as lasting as most sandstones, have as pleasing a colour, and are more easily and economically wrought.

It is not denied however by the reporters, that some magnesian limestones, not apparently different from those which are so lasting, decay with great rapidity, as a large portion of York Minster and many of the churches of York illustrate.

III. Composite Limestones.

The majority of limestones contain other ingredients besides one or both of the calcareous carbonates. A cursory examination is sufficient to demonstrate that many of them are aggregations of shells, corals, and the stony skeletons, habitations, or other solid appendages, of fresh water and marine animals.

Those shells, corals, and the like, are sometimes tolerably perfect, but more frequently are broken into fragments of various sizes, or reduced to a chalk-like powder, in which the larger fragments are imbedded. They have been fractured, comminuted, and pulverized under water, from which they afterwards deposited in sedimentary strata; these have ultimately consolidated into limestone rocks, and as such, now form in many parts of the world whole mountain masses. Rocks formed in this way must contain more or less of all the substances originally present in the calcareous (as well as some of the other) appendages of the animals from whose remains they are produced. Organic matter, accordingly, generally in the form of coaly or bituminous deposits, and phosphate of lime, may generally be looked for in such limestones. The cavities also left empty in the shells and corals, by the death of the animals once occupying them, become filled up, in some cases, by shell powder or chalk; in others by crystals of carbonate of lime; in others by siliceous sand, or clay, or bitumen, or mixtures of all.

Further, as the process we are describing is carried on under water, and irregular fragments of shells cannot cohere without leaving spaces unoccupied between them, these spaces cannot fail to become filled up with such substances as are in solution or suspension in the water; but these will be very much the same things as have already been referred to as

liable to fill the emptied shells, so that it is not necessary to enumerate them again.

It would serve no practical end to discuss, one by one, all the varieties of composite limestone. I shall be content to consider the following —

1. Petrifaction Limestone.
2. Silieeous Limestone.
3. Aluminous Limestone.
4. Phosphatic Limestone.
5. Bituminous Limestone.

1. *Petrifaction Limestone.*

This variety of stone is most familiar in its form of shell or shelly limestone; but as many beautiful building stones of our own country consist chiefly of *madrepores* and other corals, and others of *encrimites* or stone lilies (the skeletons of animals allied to star-fishes), it is better to employ a title sufficiently comprehensive to include them, as well as the shelly limestones.

The petrifaction limestones are generally dark in their ground tint, probably from the presence of animal matter more or less reduced to a coaly or bituminous consistence; but this colour of ground favours by contrast the display of the shells, corals, and other fossils, which are white or cream coloured. Fossiliferous stones of this character are of necessity unequal in structure and solidity, the matter interposed between the fossils, and binding them together, being either harder, or as more frequently happens, softer than they are. Such a mass cannot take a uniform polish, and must wear unequally; for atmospheric and other destructive agencies act with greater energy on the softer portions. But this unequal wearing does not interfere with the use of the highly fossiliferous limestones for internal decorative purposes, to which

under the name of marbles, they are largely applied; nor does it, where the stone is compact, interfere with its application in external architecture. Several of the oolitic limestones contain, interspersed among their characteristic ovules, fragments of shells, occasionally in large number. Such shelly oolites, however, are in high esteem in England, and have stood, in well-known edifices, the wear and tear of all the destructive agencies to which they are exposed for ages.

2. *Siliceous Limestones.*

Mixtures or combinations of silica and carbonate of lime occur frequently in nature, and as they unite, in certain cases, the good qualities of a sandstone to those of a limestone, they are unexceptionable as building materials.

In a well-known calcareous sandstone, that namely of Fontainebleau, we find the crystalline form of pure carbonate of lime assumed by it. Chert or hornstone, on the other hand, which is used on account of its hardness for making mill-stones, represents, in certain of its specimens, an exceedingly siliceous limestone passing into silica, and in all cases too hard for a building material.

A moderate amount of silica is not prejudicial, but probably rather beneficial to a limestone in relation to architecture. Thus, Salisbury Cathedral is built of a limestone quarried at Chillmark, in the neighbourhood of the Cathedral town, containing ten per cent. of silica; and the excellent condition of that edifice, as well as of Wilton Abbey, and many other buildings in Wiltshire, constructed of the Chillmark stone, amply prove its durability.

3. *Aluminous Limestones.*

This class of limestones is likewise named *argillaceous*, and owes its peculiarities to the presence, in the stones in-

cluded under the title, of silicate of alumina or clay. Mixtures of carbonate of lime and clay are exceedingly common in nature, but few of them are sufficiently hard and compact to come within the category of stones. It will presently appear, however, that they are of high value, though not stony in structure, as sources of hydraulic mortar. Where they are thoroughly consolidated, they are equal to combinations of limestone and slatestone, and as such cannot be wanting in durability. I name one—the limestone from Tottenhoe near Dunstable, Bedfordshire, with which Woburn Abbey, and many other edifices in Bedfordshire and Hertfordshire have been erected. It is described by the reporters on the stones for the Houses of Parliament, as "consisting of calcareous and argillaceous matter in about equal portions."

4. *Phosphatic Limestones.*

This variety of limestone has not as yet been recognized as a class, and perhaps scarcely deserves to be specially noted. It takes its name from the phosphate of lime and phosphate of magnesia, which, as they occur in the shells and other calcareous skeletons and marine animals, must be present in most limestones derived from them. Its quantity is never large, in general not exceeding $\frac{1}{1000}$th of the weight of the limestone; occasionally, however, it is ten times more abundant, amounting to more than one per cent. on the stone. As calcareous phosphates are among the most essential, and at the same time least abundant constituents of the food of plants, limestone containing them is of special value for agricultural application; and, conversely, a phosphatic limestone is the least desirable variety of its class for architectural purposes, where the growth of lichens and other vegetable matters is objectionable.

I have already referred to the very uncertain nature of the information we possess concerning the conditions which favour the growth of plants upon stones. It does not appear even to have been ascertained whether sandstones or limestones foster their growth most. Speaking solely from a speculative point of view, I should infer, that as the materials for plant-growth are much more abundant in limestones than sandstones, the former would more readily cover with vegetable incrustations than the latter; and this view appears to be justified by the tenor of the Report on the Stones for the Houses of Parliament. Yet a very competent judge, Hugh Miller, refers to the village of Olney in Bedfordshire, as "built of a calcareous yellow stone from the oolite, which, as it gathers scarce any lichen or moss, looks clean and fresh after the lapse of centuries." (First Impressions of England and its People, p. 277.) After all, however, the Olney stone must be an exceptional one, for the ancient ecclesiastical buildings of England, constructed of limestone, are notoriously spotted with lichens and mosses, at least in country places; but whether they are more so than the sandstone buildings of equal age, I am not certain, although I imagine that they are. The question must be open for future inquiry, and with it the further query, does a stone gain or lose in beauty by lichen incrustations? Most artists will affirm that it gains; nor will I dispute the conclusion. This at least is certain, that lichens and mosses protect the stone they cover from the action of the atmosphere, and do not, in the majority of cases, sensibly corrode it, their sustenance being chiefly derived from the air which surrounds them. It is an ominous indication of the unhealthiness of town atmospheres, that within them, stones remain unspotted by any vegetable marks, except those ugly green streaks which *confervae* occasion; and provided water is abundant, these seem to grow equally well on all surfaces.

However æsthetical judgment may be satisfied in reference to the lichen spots and moss stains on stones, it must sometimes be desirable to avoid them as long as possible. Where this is the case, the purest simple or magnesian limestones should be preferred; and where, on the other hand, a quick spotting is desired, the composite limestones, and especially those rich in phosphates, should be preferred.

5. *Bituminous Limestones.*

From the circumstances under which limestones have been formed, they must be liable to contain vegetable matter derived from the water in which they were originally deposited, and animal matter, resulting from the decay of the shell-fish and coralline creatures from the tenements of which they have mainly been produced. Those vegetable and animal remains have, in the course of ages, become converted into a carbonaceous or coaly substance, often accompanied by bitumen. In some cases, this matter is so equally distributed in the stone as to give it the uniform dark colour so much admired in black marble. In others it produces streaks or veins, sometimes beautifying, sometimes disfiguring the limestone. Occasionally limestones, such as the white marble from Skye, discolour and darken when exposed to the air, in consequence, as I suppose, of retained organic matter becoming carbonized by a change such as we are familiar with in exposed beds of coal. And it is probably owing to a similar but less advanced change or decay, that certain limestones, when struck or rubbed, emit an offensive odour, and have been distinguished as a class by the title of *fetid.*

Bituminous limestones must not accordingly be rashly selected as building materials; but where not otherwise unsuitable, it is likely that their bituminous impregnation will make them more durable by rendering them less permeable by air and water. We have, in the Binnie Limestone,

and elsewhere in the Bathgate coal-field in the neighbourhood of Edinburgh, a most interesting example of a highly bituminous limestone.

From what has been said, it will be seen that there is large choice of excellent building materials among the limestones. Their greater softness makes them more easily wrought, at a smaller cost, and with less injury to the health of the workmen, than is the case with the sandstones. Their colour is generally pleasing, and they are not liable to iron-spots. Theory would indicate, that they are less durable than the sandstones as a class; and this inference is borne out by the fact, that in Oxford, York, and other English cities, the decay of certain limestones employed in building has been so great in from twenty to fifty years, as to render inscriptions on monuments illegible, and efface all the finer lines of carving. This, however, is not the general character of the building limestones, which, even in our climate, have endured, without undergoing serious decompositions, the storms of many centuries.

In reviewing the list of building-stones discussed in these papers, it is worth while to observe, that there are special purposes for which each of the more important ones is adapted. Thus, granite is justly preferred for such a building as the Skerryvore Lighthouse; slatestone for floor-slabs; and slate for roofing. Greenstone, uniting hardness to a texture which prevents its acquiring a polish and becoming slippery, is peculiarly suitable for causeway stones and road metal. Fine-grained, hard, compact sandstones, like those of our own neighbourhood, are superior to every other building material for the construction of such an edifice as Sir Walter Scott's Monument, Edinburgh, where delicate tracery and minute carving are exposed to the destructive meteoric agencies of a variable northern climate and a city atmosphere.

Where, on the other hand, due protection can be given, the petrifaction limestones and true marbles can be economically wrought into pillars, slabs, wall tablets, and the like, possessed of a beauty of colour and lustre, such as no other stone can rival.

For general building purposes, sandstone or limestone will always be preferred where they can be procured. It would be folly, of course, for the inhabitants of Aberdeen to send to a distance for either, when they have inexhaustible supplies of granite close at hand; but where there is a choice, that beautiful rock is too difficult to work to be preferred to the calcareous or silicious freestones.

As to the relative advantages of sandstone and limestone, they are so nicely balanced, so far as ordinary buildings are concerned, that a small matter may be allowed to decide the choice betwixt them. The inhabitants of Bath are not likely to send to Edinburgh for sandstone; nor those of Edinburgh to Bath for limestone. Nor is there probably any district in the country, where limestone and sandstone occur equally good of their kind, equally abundant, and equally accessible. Where those rare conditions are realized, limestone would be preferable for the humbler edifices, and for the less exposed portions of the more stately ones. Such a combination of limestone and sandstone is not uncommon in our older ecclesiastical buildings; and is being carried out to some extent in the new Houses of Parliament, where the Bolsover magnesian limestone is chiefly employed, but not to the exclusion of sandstone.

In conclusion, those to whom these papers are addressed, will, I trust, not fail to make great allowance for their imperfections. Their object has been chiefly to awaken an interest in the application of chemistry to architecture, by an

example of one of the modes in which the former can assist the latter. The subject is almost a novel one; for the chemist has only begun to inquire how he can serve the builder; and in these brief addresses I could not discuss otherwise than cursorily, even a single department of chemistry as applied to architecture.

Much more must be done by the professors of my science, in the way of analysis and research, before they can give you great *positive* assistance in the selection of building stones; for at present we must confess we are at a loss to explain why one granite, or sandstone, or limestone, rapidly decays, whilst another, to appearance and analysis the same, is practically indestructible; but this only shows, that our analysis has not been sufficiently full and minute to bring out the points of difference between the destructible and indestructible specimens of stone — not that such points of difference do not exist. We can already negatively assist you by pointing out *certain* signs of destructibility and indestructibility in building materials; and with your co-operation, I trust that I shall soon be able, through the instrumentality of the Industrial Museum of Scotland, to add largely to our knowledge of the qualities of the Scottish building stones.

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TRANSACTIONS.

SESSION SIXTH,

1855-56.

TRANSACTIONS

OF THE

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OF SCOTLAND.

SESSION SIXTH,

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CONTENTS.

PAGE

Introductory Address — By The Right Rev. Bishop Terrot ... 1

I. Remarks on the Domestic Architecture of Paris — By David Cousin, Esq., F.A.I.S. 28

II. On the Architecture of Nuremberg, with Illustrations — By George Burnett, Esq., Advocate 46

III. On the Principle of Usefulness as a Governing Feature in the Architecture of the Ancients, with Illustrations — By Patrick Allan Fraser, Esq. of Hospitalfield, Arbroath 83

IV. On Wrought and Cast Iron Beams, with Illustrations — By Thomas Davies, Esq., F.A.I.S. 106

V. On the Laying Out of Open Spaces in Towns — By John Murray, Esq., Advocate 131

VI. On the Egyptian Obelisks now in Rome, with Illustrations — By Alexander Thomson, Esq., Banchory 141

VII. On the Monumental Edifices of the Egyptians — By Thomas L. Donaldson, Ph. D., M.I.A.B. 177

INTRODUCTORY ADDRESS.

Transactions of the Architectural Institute of Scotland,
Session 1855–1856.

INTRODUCTORY ADDRESS.

BY

THE RIGHT REV. BISHOP TERROT.

[*Read at the Annual General Meeting of the Architectural Institute of Scotland, held on 29th November* 1855.]

Gentlemen,

On looking over the Transactions of our Society, I observe that two friends of my own, whose professional engagements rendered it probable that their knowledge of architecture would not be very technical and precise, have addressed your meetings, and have done it successfully. But for these precedents, I should certainly have adhered to the answer which I first gave to the application from your Council, to deliver the opening address of the Session, which answer was, that I felt myself quite incompetent for the task; and even with these precedents, I still feel that there is something preposterous—I use the word in its strict derivative sense, as qualifying any arrangement where that which ought to be last is put first—as, for example, when the cart is placed before the horse—that there is something preposterous, I say, in calling upon a mere amateur to talk for an hour upon Architecture, before a society composed principally of gentlemen who have made

it the professional study of their lives. I have, however, in some degree quieted my misgivings, by the consideration, that as there exists a common sense by which thousands who know nothing of formal logic do contrive, in a rough way, to arrive at true conclusion, so there may be, and I think there is, a common taste, whereby the minds of educated and thinking men do generally agree in approving or condemning any architectural work to which their attention is directed, though they may be all ignorant of the mechanical laws or the æsthetic principles which guided the architect. The existence and the workings of this common taste, the architect is bound to take into consideration, both for the sake of the public and for his own; and it is in the belief that I possess just my individual share of this common quality, and nothing more, that I now attempt to comply with the wishes of your Council.

I have just mentioned two points which the professional architect must have studied carefully—1st, The necessary laws of matter; and 2nd, Æsthetics, or the principles of the beauty of form. Of the first of these as applied to Architecture, the class of which I profess myself to be a member, is confessedly very ignorant. We do not, for example, know the strength of the various materials employed in a building, nor consequently can we say what width may safely be given to an aperture surmounted by a horizontal lintel of sandstone, of marble, of wood, or of iron. We do not know what lateral pressure a flattened or segmental arch impresses upon its abutments; and, consequently, are ignorant what force of counter pressure, what width and solidity of buttress, is requisite for the security of the arch. But then it ought to be remembered by the architect, that though very ignorant, we are not entirely ignorant. We know that there is a limit beyond which

a horizontal beam, even of the strongest material, cannot support even itself; and, therefore, we feel a painful sense of insecurity when we have any suspicion that this limit has been approached. We know that a flattened arch of heavy materials could not be supported but by a sufficient counter pressure; and, therefore, we feel uncomfortable under such an arch, unless we see that the means of counter pressure have been provided. Such architectural discomforts I have myself experienced. I recollect being many years ago in a concert room at York, then newly erected, the ceiling of which was horizontal, and ostensibly composed of slabs of various richly coloured marbles. These, if they had been what they pretended to be, could have been kept in their place only by some very powerful mechanism, of whose existence no sign appeared; and thus the effect was a painful feeling of incongruity and insecurity; while, if the ceiling had really been what it assumed to be, and had been transferred to the floor, the effect might have been rich and pleasing. I may mention another instance nearer home. The church in which I officiate (St. Paul's, York Place) was built from the designs of the late Mr. Elliott. It is, as most of you know, in the English perpendicular style, and is, I believe, generally an imitation of St. Mary's Church at Beverley—(those who know Beverley only by its fine Minster, must not suppose that I am referring to it)—that is to say, of one arm of it; for St. Mary's is a cross church, with a central tower. Considering that St. Paul's was built very early in the present century, before the taste of the public or the study of architects had been much directed to the restoration of the Pointed or Gothic style, I think it must be allowed, that Mr. Elliott had a good artistic feeling for the beauty of the style which he had undertaken to imitate. But the point to which I

wish to direct your attention, is the internal ceiling. It is in form such as the wood roofs, common in the perpendicular churches of Norfolk and Suffolk, and which appear in the University churches of Oxford and Cambridge. The beams rest upon a tablet at each side, meet in the centre at a very obtuse angle, and are there inserted into a longitudinal beam, running the whole length of the church. As a support to the whole, there are arches, with open spandrels, above each pair of opposite piers, resting upon shafts continued through the piers down to the ground. This description is, I fear, very untechnical, but I hope it is sufficiently clear to make it understood, that nothing of the kind could ever have been executed in stone. What the substance of the ceiling at St. Paul's is, I cannot say; but it is covered with a coating of plaster, and that again was coloured and lined in imitation of stone, producing, to my mind at least, much of the uncomfortable impression produced by the marble ceiling at York. It has latterly been painted in imitation of oak, and I now feel in comfortable security. It may be proper to notice, that these are instances of architectural deception.

Now, though I would not push so far as some writers have done the condemnation of architectural falsehood, nor speak of it as actually a moral crime, still I think a high-minded architect will discourage it. False windows, false doors, false façades, all impress the mind with an unsatisfactory feeling of uselessness and incongruity. And as in such matters, no one scruples to employ the terms of moral science, I may be allowed to say, that not merely truth but candour is desirable. It has been received as a maxim, that the highest art is to conceal art—*Ars est celare artem.* Now, when or where this is true, I shall not stop to inquire. It is enough to say, that it is not true in respect of Architec-

ture. Art, true art, is a noble and beautiful thing, and instead of being concealed, it ought to be fully exhibited. Trick and artifice may be concealed, but it were better that they did not exist at all. True art consists, not in concealing that which is constructivly necessary, but in transforming it into a beauty. Let us, for the sake of an example, consider and contrast the side of a Norman with that of a perpendicular church. I am not going to compare the merits of the two styles, nor to eulogize the one at the expense of the other. I pity the man who can admire only one style, even though that style should undoubtedly be the very best in the world.

An ingenious Frenchman, in a dissertation upon styles in literature, observed, that all styles are good except the tiresome; and with a feeling akin to his, I am inclined to think, that when a building is unsatisfactory, the evil arises not from its being in this or that style, but from its being the work of an architect who did not feel the beauty nor understand the resources of the style which he had adopted.

But to return to our example. In the Norman church, we find walls of great thickness, unweakened by any large apertures; and resting upon these, we find a roof of comparatively light materials. The wall, then, is sufficient to sustain the strain upon it, and no buttress appears. In the perpendicular church, while the wall is slighter and weakened by large apertures, the roof is, in many cases, of much heavier material—it is a stone vault, which, from its flatness, requires considerable support from without. Hence arose the necessity for buttresses of great depth. They were not introduced for the sake of ornament, but because they were essential to the stability of the building. Had they been merely a great thickening of the wall, they would have served their structural purpose, but would have been utterly devoid

of elegance. It was the business of the architect to contrive some means by which that which was conducive to strength might also be conducive to beauty; and any one who has looked at the fine play of light and shadow produced by the range of the deep buttresses along the side of King's College Chapel at Cambridge, and who carries his eye from the broad base through the several stages up the richly crocketted pinnacle, must feel that had there been no necessity for buttresses, the chapel would have wanted most of its external beauty.

I have been led to mention a very well known and generally admired perpendicular building, merely to illustrate the general principle, that the glory of an architect consists, not in concealing any of the elementary portions of his building, but in exhibiting them in a form that will be beautiful, or at any rate in one that will not be offensive. It was by no means my purpose to undertake the defence of the Perpendicular style against its able and numerous enemies; nor would I dissemble my conviction, that it is a depravation of the Pointed style. Still it has beauties, and has been, I think, unfairly treated, even in respect to the relation between exterior and interior, to which I have just adverted.

A very eloquent and popular writer upon æsthetic subjects remarks, I think (for I have not his book to refer to), that the solidity, width, and flatness of the stone roof, with the absence of columns, or any visible means of support in King's College Chapel, produced a painful impression. Now, it is an important element in the case, that no one is ever in the inside of a building, who has not been previously on the outside of it; and no one can have been on the outside of King's College Chapel, without noticing the massive strength of the buttresses, so foreign to the general effeminacy of the Perpendicular style. The question is sug-

gested to his mind, for what purpose have these vast masses of masonry been erected? As soon as he enters and raises his eyes to the roof, sees its form, and understands that it is no deceptive compound of lath and plaster, then instead of having any difficulty suggested to his mind, he finds at once the solution of a previously existing difficulty — he finds that the buttresses which he felt to be beautiful, but of which he could not see the use, were what was necessary, and not more than was necessary, for the stability of the fabric.

It may not be foreign to these remarks upon truthfulness, and its kindred virtue consistency, to observe, that while the arts of painting and architecture may have many common principles, a picture and a building are very different things. A picture is intended mercly to be looked at, and that only in front. A building — that is to say, any thing that has employed the thoughts of an architect — any thing above an ordinary dwelling-house or a manufactory — is indeed intended to be looked at; but that is not its sole purpose, nay, it is not even its primary purpose. Its primary purpose is to shelter and accommodate human beings, either permanently as a residence, or occasionally as a place for public meetings. Now, in any work of art, a secondary purpose ought to be kept subservient to and consistent with the primary purpose; and it follows, that any edifice which exhibits on its façade elements, however beautiful, which have no connection with the interior structure, nor consequently with the primary purpose of the edifice, is worthy of all condemnation. I think there is a Scottish church in Regent Square, London, which exhibits this defect very strongly. Its front is an ambitious imitation of York Minster, with rich flanking towers, and a gable containing the great west window between them. There is

here the promise of a nave and side aisles, of piers, arches, and clerestory; but, without going inside, every spectator who turns the flank, sees at once that the interior affords nothing of the kind — that it is merely a large room, very well suited for its real purpose as an auditorium or place for hearing sermons, but with no more affinity to the architectural features of its own façade, than it has to the architecture of any club-house or any theatre in London. Instances of this kind are to be found in all our large towns. They throw no suspicion upon the skill or taste of the architect; he was merely asked to give a design for a pretty mask, and he gave it. But it may be worthy of the consideration of the professional members of the Institute, whether they could not do something towards checking the demands for such incongruous and deceptive edifices.

The difficulty lies here. All churches and sects among us, seem agreed that their places of worship ought to be in some mode of the Pointed style. In all the good old examples of that style, the arrangement of the eastern and western extremities is felt to be very beautiful, while the internal arrangements are found to be inconvenient for our purposes, differing as they do from the purposes contemplated by those who built those ancient models. It is very natural then, that committees should seek to purchase the external beauty without the internal inconvenience, and that thus they should insist upon the erection of the incongruous buildings I have alluded to. They will probably continue to do so until one of two things happen — either that our architects should discover some means by which beauty of external form and arrangement in the Pointed style may be made consistent with the internal arrangements required by our Protestant forms of worship, or

failing this, that we should come to the conclusion, that the Pointed style is altogether to be excluded as unsuitable to the purpose for which churches are now built.

Now I suppose there is not a member of this Society, who would not consider the adoption of the latter alternative as a national disgrace and misfortune; but I see not how it is to be avoided, unless our architects should succeed in solving the problem contained in the former alternative. Of the facility or even possibility of doing this, I feel that I am incompetent to speak. But there are considerations which prevent me from despairing, and principally, that the Pointed style is governed by great principles rather than by strict laws; and that, in consequence, it affords great scope for variety, both as to ground-plan, elevation, and internal arrangement.

First, we have the little Country Church, with its low walls, high pitched roof, its well proportioned chancel, its humble south porch, and little bell-cote surmounting the western gable; then there is the Chapel form, the single rectangle, without either tower, side aisles, or chancel, as exhibited in the chapel of King's College, Cambridge, New College, Oxford, and the very beautiful Trinity Chapel attached to Ely Cathedral; thirdly, there is the larger Parish Church, generally with a western tower or spire, with side aisles, and clerestory, a chancel and porch; and lastly, there is a form very different from all these, the polygonal Chapter-house, of which there are good specimens in many of the English Cathedrals, and I think at Elgin.

Here are four very different classes of building, all of them in use during the prevalence of the Pointed style, and the adaptation of that style to all of them seems to have caused no difficulty to the architects of those times. Now I see no reason to believe, that the possible

adaptations of Pointed Architecture are limited to these four forms; indeed, I see already that I have omitted the grandest form, that of the Cruciform Church or perfect Cathedral. If, therefore, an architect is called upon to produce a plan for a church, to contain say a thousand sitters, and in the Pointed style, he is not confined by the rules of his art to any one form — nay, he may produce a form absolutely new, provided it be consistent with the principles of the style which he adopts. In the communion to which I belong, most of our new churches are in the simple, and a few in the more extended, parish church form. For our smaller country congregations, the former of these is seemly and convenient — they would probably not suit so well for denominations more populous than ours. The latter, which is perhaps the handsomest form in which Pointed Architecture can be applied, is exposed to two grave objections. In the first place, the piers between the nave and side aisles, separate, as to seeing and hearing, a considerable portion of the congregation from the officiating minister, and the consequence is, that many seats are condemned as useless. In the second place, as the supply of money is seldom commensurate with the desire for architectural display, the architect is compelled to economize his space, to erect galleries which never did and never can harmonize with the lines of a Pointed building, and which render the piers not indeed constructively but pictorially useless. The desideratum then is, to discover the best way in which the old styles of ecclesiastical architecture may be modified so as to meet our modern requirements. It would be very rash at once to begin such experiments in stone, but I should wish to see some qualified architect, deeply impressed with veneration for the old forms, but at the same time sensible to the inconvenience attend-

ing a rigid adherenee to them, or a partial and inconsiderate departure from them, who should present the public with designs eonstrueted on this leading prineiple — the aeeommodation of old forms to modern requirements.

I have mentioned the polygonal chapter-house as one of the forms in Pointed Architecture, and I hope you have understood me as using the word "form" as expressive of ground-plan principally, with no referenee to those differenees whieh are eommonly ealled styles. In Blaekfriars' Road, London, there stands a large oetagonal brick ehapel, onee celebrated as the station of the eeeentric Rowland Hill. No one in search of the pieturesque would look at it twiee, for it is eertainly very ugly; but then, on a comparatively small area, it is seated, I have been told, to aeeommodate four thousand persons, and a voiee of ordinary strength is audible throughout the whole of it. Now, might not the style of the aneient ehapter-house be adapted to produce all this eonvenienee without any of this deformity? I suppose one diffieulty would be, the neeessary expanse of roof, but what is there whieh eannot be effected by the judieious use of iron?

If, again, the Greek or Roman style should be adopted, and I see no reason why they should be proseribed, it has struck me, that the Greek eross, whether with or without a dome at the intersection, is a form well suited for our purposes, eapable of mueh external and internal beauty, in harmony the one with the other. If built without side aisles, and eonsequently without piers or pillars, all the congregation, in three at least of the arms, would see and hear the preacher without obstruction. As employed by the Episcopal Chureh, the fourth arm would be devoted to the purpose of a chancel. I know no instanee of such a chureh in this country, but you have all seen drawings

of the Isaac's Church at St. Petersburgh — that is the form to which I am now alluding; and it does appear to me, that something of the kind, though of course on a very reduced scale, would suit our purposes in the erection of our larger city churches.

You will observe, gentlemen, that I am not so rash and presumptuous as to ask for experimental buildings in either of these forms. I ask for drawings only — plans, elevations, and sections; and I venture to say, that such a request is reasonable, for if the practical objections to the most beautiful form of Pointed Architecture be such as I have described, it is worth while that some pains should be taken to obviate them.

I see while writing this, that it is necessary I should speak hypothetically; for a very intelligent friend of my own, Mr. Beckett Denison, in his excellent lectures on Gothic Architecture, in relation to the restoration of St. George's Church at Doncaster, takes a very different view of the matter, and supports his own opinion by the evidence of the supplementary report of the Church Building Society for the year 1853. His words are — "It is also mentioned in the same report, that their committee of architects have now ascertained, though they do not profess to know the reason, that a church broken up into a nave and side aisles with pillars is generally better for hearing in than the great unbroken spaces under one roof, which there was a few years ago a passion for obtaining in large churches. I was struck with the same thing myself a short time ago, in observing the effect of the voice in two churches of about the same size — one divided the other not. I supposed it was only an accident, as the laws of acoustics are notoriously little known; but it seems it was not, and that, as usual, the old builders

knew what they were about better than the modern ones."

Now, gentlemen, no one can be more disposed than I am to believe that all this is true; for if it be true, you may at once continue the erection of churches with naves and side aisles, and spare yourself the trouble of preparing the designs of a different form which I have ventured to solicit. But with all this disposition to believe, I cannot help suspecting, that both Mr. Denison and the committee of architects have had their opinion as to a matter of fact in some degree influenced by their æsthetical feelings, just as the beauty of his mistress often misleads a lover in his estimate of her moral and intellectual qualities. There is no arguing against well attested and well conducted experiment, and yet I find a difficulty in believing, that a solid obstruction between the speaker and the hearer does not merely not impede, but actually conduces to facility of hearing. I can well believe, that the impediment is not so great as is generally supposed; that those who cannot see the preacher at all, are disposed illogically to infer, that they do not hear him so well as they should have done had they been in sight of him; and that those who really do not hear well, are more ready to refer this to another cause than to their own deafness. I am also ready to admit, that there are many other causes besides intervening pillars that may render a building unfit for the distinct conveyance of sound; and it is because the range and nature of these other causes is avowedly but little understood, that I doubt the value of the experiments made by the committee of architects. In the examination of two buildings, one with and the other without pillars, it is only when all other things are equal that we can infer that the better hearing in the one or the other depends upon the presence or the absence of pillars;

and while we are so imperfectly acquainted with the laws of acoustics, we cannot determine with accuracy whether all other things are equal or unequal. If indeed the experiments amounted to this, that the committee visited a great number of churches, all accommodating about the same number of hearers, and found that they heard as distinctly in those with as in those without pillars, and as distinctly when they sat behind a pillar as when they sat in front, I should consider the question settled. My only experience is this, that people will not occupy seats in which they are sure that they cannot see the preacher, and believe that they cannot hear him. Nothing would gratify me more, than to be convinced that the committee of architects and Mr. Denison are right; for I have no doubt, that the larger parish church with tower, side aisles, and chancel, is the most beautiful form in which the Pointed style can be employed, and that for many reasons the Pointed style is the best adapted for ecclesiastical purposes in this country. I think that some of the professional architects present must have had their attention directed to this question of the general effect of pillars, or rather of piers, upon the transmission of sound; and I think that the communication of the results of their inquiries and experience would not be unacceptable to the members of the Institute.

I shall now, gentlemen, leave these matters of comparative detail, and offer to you a few observations, *valeant quantum*, upon the general state and prospects of Architecture in our country. By our country I mean not Scotland exclusively, but the whole island. Of Scotland I know little beyond the limits of Edinburgh, and for many years little has been done there, either in the way of street building, churches, or public buildings of any great pretensions. We have, indeed, Donaldson's Hospital, a very

great work, and several new banks, well worthy of attention; but I hesitate to speak in detail of buildings whose designers may be among us, in which case praise might appear indelicate, and objections offensive.

Glasgow gives greater scope to the architectural critic, for the works recently erected, or in course of erection there, are numerous and important. My visits to that city are, however, rare and transient; and I remember only one impression remaining very strong from my last visit there, and that was, that the architects employed there must have been dealing with much more wealthy clients than the architects of most of the modern works in Edinburgh. I allude particularly to the large masses of building intended for shops or warehouses, on the fronts of which, not so much on the ground-floor, as on the frieze and cornice, much expensive ornament has been bestowed. Upon the whole, the effect is striking; but there appears to me some want of completeness and congruity — first, between the ostensible purpose of the building and its elaborate decoration; and next, between the nakedness of the mere shop front, and the profuse richness of the upper portion. They are much superior to the variety of plaster trifles exhibited in Regent Street, London, but inferior in dignity to the mercantile buildings in New Cannon Street. These are of well-coloured brick, with white stone facings of good design to the doorways and windows. This variety of material and colour, where this is a necessary and manifest break of continuity in the structure, is both reasonable and pleasing; and, upon the whole, I know not that I have seen any new range of street architecture which I prefer to New Cannon Street, between London Bridge and St. Paul's.

My holiday leisure is generally spent in London, with a few visits in the country coming or going; and after

inquiries after old friends, and visits to such picture galleries as are accessible, my next inquiry is for any thing new in the way of Architecture. And here there is something which I have in vain studied to account for, namely, that while private individuals, or commercial companies, or parochial committees, can generally get a good design for their money, Government, with the collective wealth of the country at its command, appears almost always to fail.

There is, I think, no building in London so universally and justly condemned as the National Gallery in Trafalgar Square. The unmeaning segments, each consisting of a brace of columns, or of a portion of blank wall, advancing and retreating without any purpose—I think the first time I saw it I counted sixteen such irregularities, and its fenestration manifestly unsuited to its known purpose, all combine to render it a building of which the nation is and ought to be ashamed.

If not so much in disparagement, still but little in the way of admiration can be said of the Palace in St. James' Park. It is viewed with indifference. Soon after the long front was added, I heard a story of two critics, one of whom was expressing great admiration of the addition, while the other confessed that he could not feel its beauty, and thought it rather commonplace. "Ah! but," said the more favourable critic, "you should not forget how much ugliness it conceals." Now, this no doubt is a merit—but then if the concealment be complete, it is a merit of which few of those who see it will ever think.

But the great architectural work of the day is the House of Parliament—a work of immense size and still more enormous expense. This must be spoken of in a very different tone from the buildings above mentioned. It is the work of a man of genius, and there is in it much

to admire, while to my mind there is something to regret. What I objeet to in it is, that as a single eontinuous uniform building it is too large. I have little doubt that in commeneing his designs, Sir Charles Barry had in his mind the very beautiful Hôtels de Ville in the prineipal towns of Belgium; and had he been required to provide a structure of any thing like the same extent as those hotels, he eould not have started with a better primary idea. But then it ought, I think, to have oeeurred to him, and to those who adopted his plans, to eonsider whether the same degree of height, and the same repetition of the same or similar ornament which was suitable and pleasing in a building of moderate size, might not appear low and tiresome in a building whieh is more like a town than a town-house. In the interior, however, there is mueh to admire. The broad flight of steps under the east window of the noble old hall, braneching off to the eorridors on eaeh side, is grand and palatial. For eorridors Sir Charles Barry has a speeial genius, as might have been inferred from one of his early productions — the Grammar Sehool at Birmingham. Perhaps the least satisfactory parts of the whole are the two ehambers themselves. That for the Commons has been spoiled, I believe, for the purpose of improving the transmission of sound; and the House of Lords is more marked by finery of deeoration than by grandeur of forms.

As we deseend from national edifiees to those ereeted by individuals or soeieties, we must feel that Arehitecture has, in some quarters at least, made great advanees in the last half eentury. If we eompare Devonshire and Lansdowne houses with the palaces lately built for Lord Ellesmere faeing the Green Park, and by Mr. Holford in Park Lane, it is elear, that whatever may be the internal

comfort and splendour of the former, they do not, like the latter, afford a gratifying object of contemplation to the multitude who have not the *entrée* either to the one or the other. With these aristocratic edifices we may class the more democratic club-houses which almost occupy the south side of Pall-Mall ; and whatever faults of detail may be found among them, I doubt whether the whole of the last century produced as much of street façade, which can be contemplated with any thing like satisfaction, as has been produced very recently, and within a few years, in Pall-Mall and St. James' Street.

In estimating these edifices as evidence to the state and prospects of Architecture in Great Britain, it is clear that we must not be hypercritical. There may be little of originality in the designs, and each particular club may have its prototype in some of the palaces of Rome, or Venice, or Genoa. I am not aware that there has been any servile copying, but certainly the general air of Pall-Mall reminds me, not of these Italian models themselves, which I never saw, but of the engravings and photographs of them. And of this I see not the slightest reason to complain ; for if an architect provides for his employer a commodious and elegant building, what more has any one a right to demand ?

Two of the largest clubs — the Carlton and the Naval and Military — suggested to me some considerations not foreign I hope to the purpose of this address. In the Carlton there is a very striking variety of colour in the materials. The wall-face is of the ordinary building-stone, while the ornamental columns are of red granite. This appears to me a case in which variety of colour is not merely allowable but commendable. There is here a structural discontinuity, a sudden passing of the eye from

one structural form to another, and in such cases there is nothing objectionable, when the change in form is accompanied by a change of colour. The effect is very different, when as in Mr. Hope's new house in Piccadilly, the red granite is introduced in unnecessary and unmeaning patches upon the flat wall. The Military and Naval presents two very extensive and richly ornamented fronts — one towards Pall-Mall, and the other towards St. James' Square. In the elevation, we have first a rusticated basement storey rising from the level of the street; then an *entresol;* and above that a Corinthian colonnade, with a very rich frieze and cornice. But the basement and *entresol* being all above the level of the spectator, occupy one-half of the whole elevation of the building; and this, I feel assured, is far too large a portion to devote to such purposes. The effect produced is that of one complete edifice placed upon the top of another.

Though I thus conclude my remarks upon the new street architecture of London with an adverse criticism on a particular case, I feel, and all must feel, that art is advancing; and that, looking only to the productions of the Georgian and Victorian ages, the architects and the public of the present day have no reason to be ashamed. And if in this department the appearance of improvement is undeniable, much more have we reason to rejoice at the still more marked advance in ecclesiastical architecture. And in reference to this, the hope for the future rests not more upon the skill and feeling exhibited by our architects, not in London only, but in every province of Great Britain, than upon the attention which is paid to the subject by all classes of the community, and the large amount even of technical knowledge possessed by many who are actively employed, but not absorbed in other professions. It may

be twenty years ago since Mr. Rickman told me he knew a dozen clergymen in England quite competent to produce the working drawings for a first-rate church; and if we may judge from the numerous publications on mouldings, tracery, groining, and such matters, the number and the attainments of such amateur architects must have largely increased since his day. Still it is desirable, that the working drawings should be left to the professional architect; but it must be a satisfaction to him, when he knows, that the result of his studies is to be submitted to employers capable of appreciating them, and who, in any alterations they may propose, have knowledge enough to distinguish between the possible and the impossible, and taste enough to distinguish what is beautiful from what is ugly.

In respect, then, to Church Architecture, and speaking from my own impressions, I am disposed to say, not merely that we have advanced beyond the two or three very dark centuries which immediately preceded the present, but that the productions of each year show some advance upon those of the year before. The new churches which are springing up in and about the metropolis are so numerous and varied, that it would be absurd to classify them all under any common description. But this I will venture to say, that there is hardly one of them which is not, upon the whole, a pleasing object — hardly one which would or could have been erected at any period between the reign of Henry VII. and our own time.

I venture very briefly, gentlemen, to direct your attention to two churches, neither completely finished, but both I think well deserving the attention of the architect and the lover of architecture. The one is a church between Gordon and Torrington Squares, built by the Apostolic, or, as it is vulgarly called, the Irvingite Church.

This is a Cross church, still wanting the centre tower and the western façade; early English in its style; of cathedral dimensions; the nave seventy or eighty feet in height, with an open timber roof; the choir simply but elegantly groined in stone. Behind the altar there is a comparatively small chapel, representing what in cathedrals is called the Lady Chapel. I know of nothing to compare with the delicacy and richness of the arcade or stone-stall work round this, except the similar feature in the celebrated Trinity Chapel at Ely. Upon the whole, I have reason to believe, that this church is, in respect to size, proportion, and delicacy of execution, the greatest work in the Pointed style that has been erected in England since the Reformation, and superior in many respects to any edifice built in the century that preceded that epoch. The other remarkable church is called, I think, Margaret Chapel, and is situated in the vicinity of Cavendish Square. Of this, neither the eastern nor western gable is visible, the south side being flanked at each extremity by buildings of a collegiate character. The dimensions are considerable, though far below that of the church in Gordon Square. The external material is dark red brick, with black bricks laid in diagonal lines. The tone is sombre, the contrast of colours is not striking, and it is satisfactory to think, that it cannot be much injured by the smoke of London. The great peculiarity of this church is its internal ornamentation, and the profusion and variety of colour which is introduced into it—not by paint nor by mosaic, but by the variety of the structural materials employed. The piers of the nave are of red granite, the shafts attached to them are of Cornish serpentine, the great chancel arch is of white Derbyshire spar, and the archevolts of its side arches have for their voassoirs alternate red and green glazed bricks. The interior wall is of

eourse plastered, and every spandrel and other suitable space is left for the reeeption of frescos.

It will be seen that this is a great experiment, to show how far Arehiteeture, which we in this country have eonsidered to be, like seulpture, an art having form alone for its objeet, may be heightened in its effeet by the judicious applieation of eolour; and experiments on the same prineiple have, I understand, been made by some of our sculptors. As St. Margaret's Chureh is unfinished, it might be rash, even for a more competent judge than I am, to pronounee what will be the effeet. My feeling is, that the strong eontrasts of colour will withdraw the attention from the harmony of forms, whieh must always be the great element of arehiteetural beauty; and that the architeet who depends for his effeets upon colour principally, will be in danger of neglecting the far weightier element of his art.

One other eonviction I may mention, and that is, that freseos will never be found effeetive in our great towns. As I have never been in Italy nor at Munieh, I know not their effeet there, nor the kind of light in which they are placed. But from what appears in the Houses of Parliament, I would say that freseos requirc more light than London ever affords; and that when they are brought into eompetition with richly stained windows, their effeet as architeetural embellishments is nothing, whatever may be their merits in design and expression.

Out of London, the greatest work in progress is the rebuilding of Doneaster Chureh. I call it rebuilding, not restoration; beeause, in fact, the old chureh was entirely destroyed by fire, and because the ehureh now in progress is very far from being an imitation, mueh less a *fac simile* of its predecessor. Now, this faet of the destruction of this chureh, one of the finest parish churches in the

island, with the repeated calamities of York, and the narrow escape of Westminster Abbey — all in our own day — force upon us the consideration, whether the combination of wood and lead — of an easily combustible material with another requiring the immediate presence of fire in its application — might not be replaced by some safer arrangement. The wonder to me, when I look at the little open furnaces which plumbers employ, is, not that some of our old churches have been burned, but that any have survived so long. Common sense seems to point to iron as the alternative: not to iron concealed as something to be ashamed of, but to iron manifest and avowed, which it remains for genius to apply in forms of beauty and grandeur; and to use, not because it is cheap, but because it is more suitable and more safe than any other material. I have seen this pithily expressed in a manuscript poem on art —

> "Judicious art should study to combine
> The produce of the quarry and the mine."

But to return to the rebuilding of the church at Doncaster, of which I am the more inclined to speak, because I have just been reading some very entertaining and instructive lectures delivered upon the subject at Doncaster by Mr. Beckett Denison, a remarkable person, who is at the same time a successfully practising lawyer, one of the most scientific clockmakers of his time, and a learned and acute critic of ecclesiastical architecture. When means are provided for rebuilding a decayed or destroyed church, good taste and modesty generally dictate the adoption of a design as closely as possible resembling what has been lost. But there were good reasons why this should not be done at Doncaster. The church recently burned was

but a *refacciamento* of another earlier church, which also, I think, in its day had been destroyed by fire, and the restoration had been made in the Perpendicular style, and was no very good specimen of that. The fame of the church rested mainly upon its centre tower, which was really fine, and this, I believe, is to be reproduced in its original style and magnitude. As to the body of the church, the style to be adopted was an open question, and the committee appear to have been very fortunate in having Mr. Scott for their architect, and Mr. Denison as one of their body. A narrative of the considerations and discussions upon this weighty point, forms the most important feature in the lectures to which I have alluded, and in this Mr. Denison gives the clearest and most rational account of the merits and demerits of all the distinct styles of English Architecture of which I have yet met with. The Norman, the Lancet or early English, the Geometrical Decorated, the Flowing Decorated, and the Perpendicular, are all described, and the prize is given to the Geometrical, as standing in the central and culminating point of English ecclesiastical architecture, which advanced up to it and declined from it; and this is the style adopted, and in which the church is now in course of erection. As to any design of a Greek, Roman, Romanesque, or Rennaissance character, Mr. Denison appears to think that its adoption would have been as absurd as for him to have addressed the good people of Doncaster in Greek, or Latin, or Hebrew. The lectures are illustrated by ground-plans and perspective views of the old and new churches, and a detail drawing of the new east window, which last gives a fair indication of the style adopted throughout the edifice. I venture to recommend this little work to any architect who may be called upon for designs for a

new church. Not that I imagine it will teach him any thing in his art which he did not know before, but I do think it may enlighten him as to that which it is very desirable he should understand, namely — as to the extension of sound knowledge and a correct taste among those who are not professional architects. It is difficult to say whether the advancement of art depends more upon the genius and science of artists, or upon the extension of a true feeling for art among the community for which he labours.

I hope, gentlemen, you will not think that I have dwelt at improper length upon the Pointed style of Architecture, and upon its application exclusively to ecclesiastical edifices. Indeed, with the exception of the old halls or banqueting rooms — a class of buildings, so far as I know, exclusively British — I know not to what other purpose the Pointed Architecture can properly be applied. For club-houses, banks, and ornamental street architecture, either some form of Italian, or that which is commonly called Tudor, must be adopted. It is therefore, I think, absurd to vilify styles to which we must have perpetual recourse. Certainly no Italian style is so beautiful as the English Pointed in its best state; and it is equally true, that no street, or club, or bank, or insurance office, or theatre, that I have seen, is so beautiful a work of art as Lincoln Cathedral; but it does not follow that any of these would be improved by putting upon them a mask copied or adapted from any portion of Lincoln. The highest beauty cannot be employed to every purpose; and I do not see that we have much reason to complain, if it should turn out, that the highest beauty can only be satisfactorily employed to the highest purpose.

Of pure Greek Architecture I have said nothing, not because I hold it cheap, for in its best examples it is perfectly

and unexceptionally beautiful, but because it is inflexible — unsuited to our purposes, and unsuited to our climate. There are very few days in the year that we require to be sheltered from the sun; and the deep porticos which were refreshing to the inhabitants of a Greek city, would be damp, cold, and very far from congenial to us. Of course, I do not understand that a building is in the Greek style, because it has a Greek cornice running along its face over a row of unmistakeably English windows; or because it has in its centre a Doric portico, architrave, and tympanum; where there is in reality no gable, and where the laborious and heavy ornament might, so far as structural purposes are concerned, have been as well placed at any other part of the building. Indeed, I do not know that we have in this country any modern building avowedly and completely designed upon the model of the Greek temple. The unfinished fragment on the Calton Hill, which, however, always puts one in mind of the Temple at Sunium, testifies, I think, that this is not the sort of thing that our climate and our purposes require.

And now gentlemen, let me in conclusion, offer a few observations upon the character and objects of our Society. It is, in the first place, socially useful, that three very different classes — the professional architect, the professional builder, and the non-professional amateur — should occasionally meet together to discuss subjects interesting to all. It is good for the professional man occasionally to hear his daily business treated not as a trade, but as an art resting upon a science — as something in which not only his immediate employers, but all who, upon any settled principle, prefer beauty to deformity, feel an interest and entertain an opinion. It is good, on the other hand, for the amateur, who builds his castles in the air, to have his fancies checked by those whose imagination has been educated to submit to

the irreversible laws of nature. Should nothing more than this come out of our Association, it will have been far from useless either to art or to our social relations.

After this, the business of our ordinary meetings, I know of no object more deserving the attention of the Institute than the formation of an Architectural Library. This has been held out as one of our leading objects, and donations to it have been made by several of our members. It cannot however be said, that we have as yet laid even the foundation of a good library; nor do I think that such a foundation can be laid in any other way, than by judicious purchases by the Institute itself and from its own funds. The books presented must be such as the donors have and can spare, and these may be of a very different character from those which the Institute needs, and would purchase if it had the means. What we especially need are those works which a young architect would require to consult, but which from their price he could not, at the commencement of his career, purchase without inconvenience and imprudence. Especially we ought to procure foreign works of merit, particularly of the French and German schools. Art exists and is in active operation beyond the limits of our own island; and it is most desirable that our architects and students of Architecture should know something more of what has been done recently at Paris, and Munich, and Cologne, than they can learn even from technical descriptions.

And now, gentlemen, I must bring this *farrago libelli* to a close. I am aware, that it is undeserving of the attention you have paid to it; the fault, however, of its deficiencies lies not with me, for I have really done my best, but with your Council, who on this occasion have failed in putting the right man into the right place.

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No. I.

REMARKS

ON THE

DOMESTIC ARCHITECTURE

OF

PARIS.

BY

DAVID COUSIN, Esq., F.A.I.S.

[*Read at a Meeting of the Institute in Edinburgh, held on* 17*th December* 1855.]

The few observations I have to offer on the Domestic Architecture of Paris are of a very cursory nature, gathered on a recent occasion during the course of a hurried visit to the Industrial Exhibition of France.

The public buildings of this magnificent city — its palaces and gardens, its halls of assembly, its courts of justice, its picture galleries, its Champs Elysee, and its numerous churches — present strangers with such varied sources of attraction, that it is only after repeated visits one ever dreams of looking into the social arrangements which mark its street architecture, and dwellings of the middle and working classes.

It may be proper to remark at the outset, how dangerous it is, amongst so much that is different from the habits of our own country, to draw inferences as to the character of

a people from their social habits or household arrangements, which at best we can but imperfectly understand. All of us must have been amused at the representations of the social habits of our own country, which have been given by passing visitors, often founded on incidents that were in some cases exceptional and in others entirely misunderstood. Hence the necessity, in similar circumstances, of caution in forming opinions in regard to our continental neighbours.

It is perhaps unnecessary farther to remark, that many of the points noted as peculiar to the houses in Paris are common to those of many other continental cities. The contrast is meant to apply as between the arrangements of the Parisian houses and those of our own, and not as between the different cities abroad.

The streets of Paris, with the exception of the Boulevards and other leading thoroughfares, even in the fashionable quarters, are rather narrow. The houses are in general lofty, ranging from four to six stories. Except in the aristocratic quarters, the street floor is generally occupied by shops, with an *entresol* above, reached by interior spiral stairs, occupying marvellously little space. On the first floor we have a series of apartments on one level, occupied by one or more families, according to the quarter of the city or description of building. In many cases families of high social position occupy the first door in the stair, as we say, with a series of similar dwellings above, all entering by the same stair.

The external elevations of the street architecture are of a marked character, and in most cases of good design. The fenestral apertures are always more or less decorated; even in the common streets we seldom meet with those mere apertures for light, destitute of dressings of any kind, so common in some of our best streets. The windows of the first

and second floors are generally finished with architectural dressings, such as architraves, or panelled pilasters, with a good deal of carving on them, and on the trusses, frieze, and cope above; having handsome cast iron balconies, generally bronzed or painted of a dark brown shade, the smaller members and carvings enriched with solid gilding, which produces a sparkling effect. The buildings have generally a massive well-proportioned cornice, enriched with the appropriate decorations of the order to which it belongs, surmounted by an attic story, in which the mouldings are always of a subordinate character; never, as in so many cases nearer home, do we find the cornice of this part of the façade coming into competition with that of the main building. The care with which all subordinate ornamentation and detail are proportioned with reference to the main features of the building, forms a marked feature in many of the modern houses. The dressings of the upper floor windows, as they approach nearer to the main cornice, are always subdued in power by lessening the projections; the effect in some cases being produced by sinkings rather than by raised moulding, so as to prevent these details from coming into competition with the main cornice, and thereby lessening its power. In some cases I observed this has been carried to the extent of making the dressings of the windows, immediately under the main cornice, scarcely more than surface decoration, the forms being indicated rather by lines than by shadows. The effect was striking, and on the whole pleasing; the general outline of the building was thereby well defined, and a repose and simplicity of effect produced, which would have been lost had the minor features been more prominent.

The windows of the first and second floors, where there are balconies, generally reach to the floor, and are fitted with

casement frames, opening in the centre like folding doors. In summer the casements are thrown open, showing the rich hangings within, often enlivened by groups of figures giving a sprightly aspect to the scene, which we look for in vain in our own streets. The houses are uniformly built of free-stone of a white colour—which, from the absence of smoke, is preserved even in the older streets; and thus, with a strong sun, a clear sky, and well-defined shadows, the street architecture of Paris has a brilliancy of effect, which presents a marked contrast with the russet gray of our older streets, or the dingy brown of the rows of brick houses of London.

In passing along the streets of Paris, the most casual observer can scarcely fail to remark, that the entrance to houses of all classes differ greatly from those which we are accustomed to see here. In the crowded thoroughfare, in the private streets; in the houses of the working-classes, as in those of the aristocracy, one never fails to meet the large gateway, or *port cochière*, leading into an inner court which forms so marked a feature of the Parisian architecture. In street architecture, these courts are always surrounded by buildings, let off into separate flats, forming so many different dwellings. The staircases to the different portions of the building are within the entrance-gate, which is kept by the *concierge* or porter, so that access is closed against strangers, unless they can give a good account of themselves. The stair to the front buildings next the street, in which the better class of houses are situated, enters from the corridor, while those leading to the back apartments enter from the quadrangle, and occasionally serve as the kitchen entrance of the apartments in the front building, when these are of a superior class, requiring such accommodation.

The entrance gate is always a subject of decoration, even in common houses, and in the better class of houses they are enriched with delicately cut and well-designed ornament. Those of the early part of last century display the characteristic ornamentation of the age of Louis XIV. in which many beautiful specimens of that rich style of ornament are exhibited. In the more recent buildings, the Renaissance and Italian styles are adopted, exhibiting an equal amount of tasteful decoration. Indeed nothing is more remarkable than the genius of the French architects in ornamental design. Their drawing is always perfect, and the workmanship often equally so. A carefulness of finish, and attention to minute detail, is manifest in most of their works, ranging from the decoration of the grand *port cochière* of the ducal residence down to the mere cast-iron guard placed at its base to protect the angles of the masonry from the carriage wheel as it rolls into the court.

The passage or corridor between the street and the inner court is always, even in common streets, a subject of architectural decoration. In the better class of houses, its walls are enriched with pilasters and niches filled with statuary, and the ceilings arched, or subdivided by beams and panels, which serve as a ground for ornamentation. The whole is painted in imitation of some light marble generally thrown into panelled compartments by varieties in colour. The doors enclosing the corridor are always enriched, the panelling being filled with pateras or masks, and painted imitation bronze, having handsome knockers of good design. Occasionally these doors are of cast-iron work, in which case there is always an abundance of rich ornamental work, often painted in imitation bronze, and heightened with gilding. The French architects seem to

put forth all their powers in designing these entrances, many of which are extremely beautiful and well worthy of study.

In walking along the crowded streets, nothing gives one greater pleasure than the occasional glimpses into the beautiful corridors and inner courts of the finer mansions. The stillness within contrasts singularly with the bustle of the street. The marble walls of the corridor, with its niches and statuary; the masses of foliage and flowers in full blossom, with groups of statuary, which occasionally adorn the courts, combine to produce an effect of the most agreeable kind, and form a marked contrast with the monotony of our streets. The corridor and court, intermediate, as it were, between the bustle of the thoroughfare and the privacy of the mansion, partake of the elegance of the interior, and serve to stamp the character of the mansion on its threshold, and to give even the passing stranger a share of the enjoyment arising from the artistic decoration within its walls. Even in the common street houses, occupied by mechanics, we find the interior courts enlivened by the nastartium, and such common plants, growing in profusion, the deep green of its graceful leaf contrasting well with its orange flowers. These take the place of more expensive decoration—the effect is refreshing, and shows how well the French understand the use of flowers, and how much may be accomplished at a very small cost.

Having thus described the entrance gate and corridor, let us enter the court of an ordinary street. We find that it is surrounded by buildings, those next the street being more lofty and of a superior class to those in the court; those facing the quadrangle are of the plainest description. The windows are wide in proportion to their height, filled

with easements, which in summer stand wide open all day long. The *concierge* or porter who has charge of the gate, has an apartment entering from the corridor. The following extract from Dickens's "Household Words," gives a graphic description of this portion of the domestic arrangements of the house —

"The French, like the Scotch, live one over another under the same roof in the separate floors of large houses, thus economizing space and money. In the principal streets the ground floor consists of shops, then comes a mezzanine floor, or entresol, then a suite of rooms on the same level, which includes every convenience for a family, and so up and up to the highest floor. This is usually divided into two sets of apartments for residents of humble means. At the end of a pretty tesselated passage between the shops, there is at the foot of the stairs, a snug little glass case or lodge. Looking in, you will usually see a woman in a clean cap knitting a stocking, a gilt pendule is certain to be ticking on the chimney-piece, and a clean bed enseonced in an alcove. This woman's husband, always dressed in the morning in a cap and a coarse green apron, is one of the trust-worthy and serviceable class of domestic hall keepers or porters, for which Paris is remarkable. He polishes the stairs, polishes the banisters, polishes every thing he can lay his hands upon, and has generally polished his own manners too. He is shrewd, steady, observant, and can keep his own counsil withal. Every floor pays him a small fixed monthly stipend, and he is the guardian genius of the whole house. You ask his wife on which floor your friend lives, and she, the portress on duty, takes all sort of pains to make you understand her directions, if she sees there is any dulness in your foreign apprehension. You ascend a flight of

oak stairs (carefully, for the porter husband is polishing his way down from the top vigorously), by the help of a banister supported by bronzed and gilt rails. Your friend's door opened, admits you to a little hall, in which when it is shut after you, you feel as much isolated from the world as if you were standing on the mat of the private residence of the honourable deputy of St. Vitus's, Back-lane, near Camberwell Green. Little drawing-rooms, dining-room, study, nursery, bedrooms, kitchen (and a back stair leading to it for servants and tradesmen), all furnished with an amount of sensible taste, highly suggestive to all the deputies in all Camberwell. And all — horrid idea! — over a shop. Yet your friend may be an English baronet or foreign count with thousands a-year, and some capital horses in a stable close by."

In many cases, the "little hall" referred to in the above description is awanting, and you enter from the staircase directly into an apartment which serves at once as a dining hall and ante-chámber; from which the drawing-room or saloon and all other apartments enter, including even the kitchen, where there is no separate back stair. The French deal greatly less in dinner parties than the people of the same class in this country, and as a rule they sit a much shorter time at the dinner table. The dining-room, therefore, in the middle class houses, is a less important room than it is with us. The saloon or drawing-room is the living room of the family, where they receive their evening social parties. The floor of the dining-room, often without a carpet, is either of glazed tiles or polished oak boarding. The bedrooms generally have an entrance from the drawing-room, and are so arranged in plan as to admit of a separate door into the kitchen, passage, or the dining-room. The beds are generally placed in an ample recess, closed during

the day by folding doors, with a circular panel in the wall above for light and air. Adjoining the bed recess is a small dressing-closet, with an entrance from the recess as well as from the room. The floor is laid with glazed tiles, and the usual apparatus for dressing supplied, without requiring to enter the room, which is usually furnished as a parlour.

In the smaller class of houses, occupied by respectable families, we find such recesses for beds entering from the drawing-room, so carefully do the French economize space. The floors of the rooms are generally laid with diagonal boarding, stained, and so carefully polished as to render it difficult for unpractised feet to walk over them. The carpets seldom cover the whole floor, a broad margin being left round the wall, so that the heavier furniture stands clear of it, which renders it less bulky and easily lifted. Indeed, in the warm summer weather, the floors are often without carpets entirely.

The kitchen is generally a very small apartment, as compared with those of our own houses, and but sparingly supplied with closets or scullery accommodation. From the peculiar construction of the kitchen range, little heat, dust, or smell, is created in cooking. The cooking apparatus of ordinary houses consists of a series of small choffers, heated by charcoal, raised on a platform about the height of an ordinary table, on which kettles or pots of various sizes are placed for boiling or stewing meat. They have, besides, a small portable fire place and oven, so light as to be easily lifted about, for roasting meat, which is placed on the same platform when in use. A projecting hood envelopes the whole platform, and carries off all vapour or smoke into the chimney. Charcoal is always used in the kitchen, and generally wood for the room fires, though

coal is now getting more into use than formerly. The kitchen is supplied with a stone sink to receive and carry off the slops from washing dishes and the like. Clothes are seldom washed in the house, being generally sent to washing establishments, which one sees in abundance floating like arks on the Seine, in which the busy laundresses ply their calling, the Seine supplying them with abundance of pure water. There is no supply of water to any of the houses in Paris: it has all to be brought from the wells in the streets by water-carriers, who are paid at the rate of two or three shillings a-month (or more), according to the supply. Water, therefore, is a comparatively scarce commodity in the houses, although it flows very plentifully in the streets, in the water channels of which it is allowed to run for two hours in the morning, when they are being swept by the dustmen, and also for a similar period in the after part of the day, by which means the street gutters are kept pure and sweet, even in the hottest weather.

If there is such an abundant supply of water in the streets, what shall we say for the *cabinet d'aisance*, where there is not a drop, except in a brown jar, which is placed in the corner of the small apartment. Any description of this necessary convenience, even in some of the best hotels, is impossible. With all the elegance and refinement of the Parisian, this is a department in which he is a hundred years behind us. In the better class of houses you sometimes meet with this convenience, such as it is, often in a dark, ill-ventilated corner. In other cases you have only one or two such, common to the whole stair. In no case is there a supply of water; and the whole aspect of the place is most offensive. The man of energy and skill sufficient to work out a general improvement on this de-

partment of the domestic economy of the Parisians, would deserve to be immortalized. The want of water supply in the upper floors of the houses, and the prohibition of drainage into the Seine, present such obstacles as to render our ordinary plumber's apparatus unsuitable. With a supply of water in every house, such as we enjoy here, and a separate system of drainage, all difficulties would be removed. And it is to be hoped that the present Emperor, who has already done so much for the improvement of Paris, will not cease till he has accomplished this most desirable object. A pipe, with a trumpet-shaped mouth, fitted with a wooden seat, is the amount of the apparatus in use. It is carried directly into the fosse d'aisance, or cess-pool, in the back court or cellar floor, under the building, always in a perpendicular line with the soil-pipe, as no bends are allowed, or would work, in consequence of the want of water. These receptacles are all built by *rule*, under strict surviellance of the police, so as to be perfectly tight. They are cleaned out by the police authorities, or by a public company. The mode of doing so is ingenious. A large barrel or tun, on a cart, is brought to the spot, the air having been previously exhausted by an air pump, a hose is let down into the fosse d'aisance, and the contents rush into the exhausted receiver. Great pains are taken to make a thorough cleaning while they are at it, the whole being lime-washed and purified.

While all surface water, therefore, and the slops of the kitchen and scullery, are carried by drains directly into the Seine, no soil whatever is allowed to enter the river, which is kept nearly as pure in passing through Paris as it is before entering it, and which thus diffuses a cool and healthy current of fresh air through the most crowded parts of the city, greatly counterbalancing the evils arising

from the defective system of drainage to which I have referred.

The elegance of the interior decoration of the cafés and restaurants of Paris must have struck every one who has visited that tasteful capital. The same quality of decoration pervades the private dwellings, varying in extent according to the means of the occupants.

The wood work of the drawing room is generally painted in a light shade, nearly white, the smaller members of the mouldings being gilded. Oil paint is seldom used for the walls; when it is so, the shades of colour are generally light, of a gray, drab, or green hue, formed into panels, and ornamented with stencilling in a light shade. More frequently the walls are papered, which is generally of a low tone, the ornaments flat, of the same shade as the ground. Green, gray, or French white are the prevailing colours, finished with an ornamental gold border. We rarely find those gaudy papers, with garlands of roses and other imitations of natural flowers, which pass here for French papers. These gaudy designs are, I fear, prepared by the manufacturers to meet the demands of their customers on this side of the channel. The ceilings are generally white, the plaster ornaments hatched with gold; the smaller members of the enrichments being done in solid gilding, which is distributed with great judgment, so as to bring out the detail of the ornament rather than to obscure it by a dazzling display of gold on the prominent features. Mirrors are introduced in great profusion. The mantel-piece, even in spacious saloons, is usually very low as compared with ours, seldom exceeding $3\frac{1}{2}$ feet to the top of the shelf. In this way the mirror becomes a serviceable ornament, and forms a pleasing feature of the mantel-piece, in which the decorations and figures in the apartment are reflected; very often

a corresponding mirror is placed on the opposite wall, reaching to the floor, which gives a double reflection, and has a striking effect on entering the apartment, the dimensions of which appear to be greatly enlarged.

In the finer mansions, this is carried to a still greater degree of artistic effect, by the introduction of mirrors at the opposite ends of separate apartments, the centre panel of the division wall being opened up, and a sheet of polished plate glass introduced, so that the vista of both rooms is repeated at each end by the mirrors. I observed a very striking and beautiful effect of a similar kind in one of the dueal mansions in the Faubourg St. Germain. The apartment looked into the garden, and was lighted by three tall casement windows carried down to the floor, and filled with plate glass; immediately in front was a colonnade, with statuary and vases tastefully disposed, and at the end of the garden a rich mass of foliage formed a natural alcove for a beautiful group of statuary; a grass lawn and pateras of flowers occupied the space between the colonnade and the shrubbery in the back ground. Within the apartment, and on the wall opposite the windows, were three mirrors, corresponding exactly with the windows in size and mode of finishing. Whichever way you looked, therefore, whether into the garden or to the opposite wall, you had the same rich groups of statuary, vases, flowers, and foliage. The effect was extremely beautiful.

The hotels or mansions of the great are never, in Paris, placed on the line of the street, as with us, but are always preceded by a court and followed by a garden. The façade towards the street is sometimes a mere wall enclosing the front court. More generally, the apartments of the concierge and the coach-houses occupy the building next the street, in the centre of which is the gate and corridor. The stabling and

other offices and servants' apartments are placed on the right and left of the court; all of which are kept in the most perfect order. The stables are well lighted, the floor laid with glazed tiles; an ample supply of water, pure air, and thorough cleanliness, remove all objections as to the proximity of the stables to the house.

Opposite the entrance gate is the approach to the house. The hall, vestibule, and stairs in such mansions are generally of great richness, announcing by their dimensions the dignity and grandeur of those who inhabit them. Statuary and bas-reliefs, often from the best classic models, prepare the mind for the grandeur of the reception rooms, which are always disposed with a view to artistic effect.

The gardens are generally laid out in the geometrical style, so arranged as to form vistas from the windows of the saloons. The trees and shrubs, leafy and fresh-looking, form the back ground, giving an idea of much greater space to these enclosures than they really contain.

I cannot close this hurried and imperfect notice of the Domestic Architecture of Paris, without adverting to the magnificent improvements which are in progress under the authority of the present Emperor, who, irrespective of all other claims, merits the lasting gratitude of Paris for the grandeur of his conceptions on this point, and the taste and energy with which they are being realized. The district in the vicinity of the Tuileries, extending for upwards of a mile along the north bank of the Seine, containing palaces, churches, public institutions, and dense masses of crowded streets; in fact, a whole quarter of the city has been cleared away to give place to these improvements. The grandeur of the new buildings, and the almost miraculous speed with which this vast amount of work has been performed, bespeak an energy and power, and a feeling for art in the present

ruler of France, unequalled by the Grande Monarque himself, or by the First Napoleon — these mighty names of France.

Those only who have seen Paris now, and as it was but a very few years ago, can form any conception of the vastness of the works referred to — the attempt to characterize which is apt to be considered mere exaggeration. Every district exhibits the same spirit of improvement. The additions to the buildings of the Champ de Mars, the New Hotel of the President of the Council, the New Church in Rue l'Université, and the permanent buildings of the Exhibition, all attest the high professional acquirements of the modern architects of Paris, who in no period of its history have ever been surpassed.

These splendid edifices however are, each and all of them, thrown into the shade by the magnificence of the additions to the Louvre, which has now been united to the Tuileries, forming one vast palatial edifice, half a mile in length, unequalled perhaps in the world for extent and magnificence. These splendid works, which baffled the energies of Louis XIV., and all his successors on the throne of France, were attempted by the First Napoleon, who was forced to abandon them as too vast for even his power. It was left to the comprehensive mind and firm will of his nephew to grapple with the herculean task, and to master it.

The manner in which this great work has been carried out by the architect Visconti, stamps him as the greatest master of the age. The new portions, which now unite the palaces of the Louvre and the Tuileries, consist of two separate blocks of buildings, the one 700 feet long by 290 feet in depth, containing three courts, two of which average 200 feet by 140 feet; the third being of smaller dimensions.

The corresponding block on the opposite side of the square is 600 feet by 230 feet, also containing three interior courts. It may assist one to form an idea of the extent of these erections, to state, that the interior court of Holyrood Palace is 90 feet square, and the interior court of the Royal Exchange 88 feet by 85 feet; and that the length of the Louvre and Tuileries, now united, is equal to that of Princes Street from Charlotte Square to Hanover Street, the breadth being equal to the space from Princes Street to the centre of the garden between Queen Street and Heriot Row.

Whether we consider the consummate ability with which these masses of buildings have been arranged, so as to unite and form a harmonious composition with the architecture of the three previous centuries, or the vast resources of art, and the originality of design displayed in the several façades, or the carefulness of finish and matured taste which runs throughout the whole of the parts, we are equally impressed with a feeling approaching almost to veneration for the gifted architect to whom the world is indebted for this great work. The premature death of Visconti, two years ago, may almost be considered a world's loss to art. All honour to his name.

Before concluding, I may be permitted, in a sentence or two, to allude to the astonishment with which one beholds for the first time the multiplicity of royal palaces in and around Paris. That just referred to, as of such magnitude, is only one of a series. There is the Palais Royal — on the opposite side of the street — at present occupied by Prince Jerome Bonaparte. In the Champs Elysee there is the palace of the Elysee — the residence of the present emperor during the days of the republic. In the Faubourg St. Germain there is the stately old palace of the Luxembourg; a few miles to the west is the beautiful

palace of St. Cloud on the Seine, so reeently distinguished as the residence of our beloved queen during her visit to Paris. A few miles beyond this, which may be reached by a drive entirely through the royal domain, is the magnificent palace of Versailles; not to speak of Neuilly, half a league from the Barrier de l'Etoile, or of Malmaison, three and a half leagues west of Paris, the favourite residcnce of thc Empress Josephine, or Fontainebleau, with its terraces, gardens, and statuary, and its forest of 35,000 acres.

These stupendous architectural works all serve as the repositories of the kindred arts of seulpture and painting, and all are freely thrown open to the pcople. The gilded halls and corridors of these imperial mansions are erowded with the artizan and the peasant on their oft-recurring holidays, enjoying the highest works of the chisel or the pencil.

There is no crowding, no jostling or elbowing past each other. The greatest politeness prevails. The art-education thus afforded to the masses has done its work effectually in refining the manners, and inducing that outward decorum, which in this country is looked upon as thc characteristic of the upper classes only.

The amount of rational and clevating enjoyment thus afforded to the great bulk of the people by these places of publie recreation, is cheaply purchased, if they have in any degree aided in leading to those habits of *politeness* and *sobriety* whieh form such a marked eharaetcristic of the French people.

In comparison with the treasures of art every where displayed in and around Paris, nothing whatever has been done by thc government of this country for the encouragemcnt of rational amuscment, or the refinemcnt of taste in the great body of the people.

But to come nearer home, may I be allowed to make a passing remark before closing, as to the accommodation afforded on the occasion of the yearly visit to our city of the beloved Sovereign who graces and dignifies the throne of this mighty empire. Inspired by feelings of loyalty, our citizens often express a wish that her sojourn could be prolonged amongst us. But if we look at the miserable accommodation afforded by the fragment of an old palace, in part dilapidated and in part gifted away to others — its dank court, covered with green moss, on which the sun rarely shines — its miserable patch of a garden, surrounded by cow byres and mean dwellings — can we wonder that the stay of the august visitor should be of the shortest?

Is it creditable to our taste as citizens, or to our loyalty, as subjects of so benignant a Sovereign, that such a miserable residence should be allotted to her Majesty in passing through the capital of her ancient kingdom of Scotland?

The French manage these matters better.

No. II.

ON THE

ARCHITECTURE OF NUREMBERG.

BY

GEORGE BURNETT, ESQ.
ADVOCATE.

[*Read at a Meeting of the Institute at Edinburgh, on 7th January* 1856.]

OF all the ancient towns of Germany, none is more interesting to the lover of the fine arts than Nuremberg. Its fantastic, irregular, and richly decorated streets, its turrets and oriels, its Sebalduskirche and Lorenzokirche, and its "Schöne Brunnen" are all so thoroughly mediæval, so unlike the prosaic and lifeless architecture of the nineteenth century, that the stranger, who for the first time beholds them, can almost believe himself transported to the age of Adam Kraft, Peter Visher and Albert Dürer.

The architecture of this quaint old city is closely connected with its history. Founded as is generally believed by Conrad the Salic, in the beginning of the eleventh century, Nuremberg early attained the privileges of free market, custom, and coinage, and rapidly extending and rising into commercial importance, was declared by Henry V. independent of any sovereign but the Emperor. The *Burg* or Castle was at the same time given in charge to an officer called

a *Burggraf*, chosen from the nobility of the empire. By and by the Burggraf from being the protector, became the oppressor of Nuremberg. The council of twenty-six citizens who administered the civic affairs, holding themselves responsible to the Emperor alone, were disposed to resent any undue stretch of power on the part of his representative. Another grievance existed in the predatory incursions of the robber knights from the fastnesses of Upper Franconia. Yet in the face of all adverse circumstances, Nuremberg rose in wealth and importance, and began at the same time to be distinguished for the cultivation of the Arts. She continued to enjoy a considerable share of imperial favour, diets being held within the walls, and the Burg becoming a frequent residence of the Emperors. Her geographical position was also a great cause of her prosperity. The African continent not having yet been circumnavigated, all the merchandize from the East necessarily came overland into Europe; and Nuremberg being about equally distant from Venice and other trading towns of Flanders, was conveniently situated for a central entrepôt.

During the fourteenth century the wealthier and more influential citizens began gradually to form themselves into an aristocracy, and monopolize the functions of government. The administration of affairs was committed by them to seven magistrates chosen from their number. In matters of special importance, the three eldest of the seven only were allowed to act, one of whom was minister of war, and the two others called, the "Losunger" (collectors of the "Losung," or tribute), had the public treasury at command, and enjoyed an almost unlimited authority. Various privileges were conferred on Nuremberg by Charles IV. at the diet at which the "Golden Bull" was promulgated. According to that famous constitution, Nuremberg became

the chief city of the empire, and each new emperor was bound to hold his first diet there.

Meanwhile the office of Burggraf had become hereditary in the house of Zollern; and when Sigismund sold the Marquesate of Brandenburg to the representative of that family, the latter, in order to raise the purchase-money, parted with the Burg and a portion of his rights to the town of Nuremberg for 120,000 florins. The citizens having thus got rid of the Burggraf as a neighbour, dismantled and destroyed the greater part of his fortress.

Before this period Nuremberg had attained her climax of external prosperity. She was the centre of the glory and wealth of the empire, taking the lead both in commerce and in the arts; and though luxury and demoralization had already made their inroads, the Nurembergers were, on the whole, a virtuous community, and their privileged classes most frequently used their power for the benefit of the people. Then came the era of the Reformation, when that feeling of sturdy independence which, at an earlier period, had led the citizens to resist manfully all encroachments on the part of the Holy See, now induced them to take the lead in throwing off the yoke of the Popedom. Though Nuremberg was no longer capable of rearing glorious architectural monuments like those of former days, and Adam Kraft, her greatest sculptor, had been some years in his grave, yet, this was the age when Albert Dürer painted, Pfinzing composed his "Tewrdanek," and Hans Sachs cobbled shoes and lampooned the clergy. The artificers of Nuremberg, in all departments, were really artists: the painters of glass, carvers in wood and ivory, goldsmiths, armourers, and casters in bronze, stood unrivalled, and Nuremberg "Witz," became a proverb throughout Europe.

The succeeding century, however, saw a change come over the current of affairs. Commerce fell off, private animosities increased, and public honesty declined. The patrician government becoming corrupt, postponed the public welfare to the aggrandizement of the aristocracy. In the dungeons beneath the Rathhans, a tribunal whose very existence was shrouded in mystery, sat on the lives and liberties of the citizens. The privileged classes, forgetful of that commerce by which their ancestors had been elevated, neglected the trading interests of the town, and attempted to cope with the nobility of the empire.

Meanwhile other causes also contributed to Nuremberg's decline. A demand arose for cheap and inferior workmanship, in which the Nuremberg artisans could not compete with those of other towns: and things were in this state when the Thirty Years' War broke out, and religious feuds were kindled all over Germany. Nuremberg suffered severely during the war, her financial resources being completely exhausted in upholding Gustavus Adolphus against Wallenstein. Her downfall was completed by the Seven Years' War, and the events which followed it. What the French left the Austrians took; Bavaria and Prussia joined in the work of spoliation, and in 1806, the republic was, by a decree of Napoleon, declared to be at an end, and Nuremberg handed over to the king of Bavaria. No more favourable event could have occurred to the old town than this annexation. The republic was not only effete, but its coffers were exhausted, and the Bavarian government recognizing the debt and extending the privileges of the citizens, has enabled Nuremberg to exhibit some faint yet unmistakeable evidences of reviving vigour.

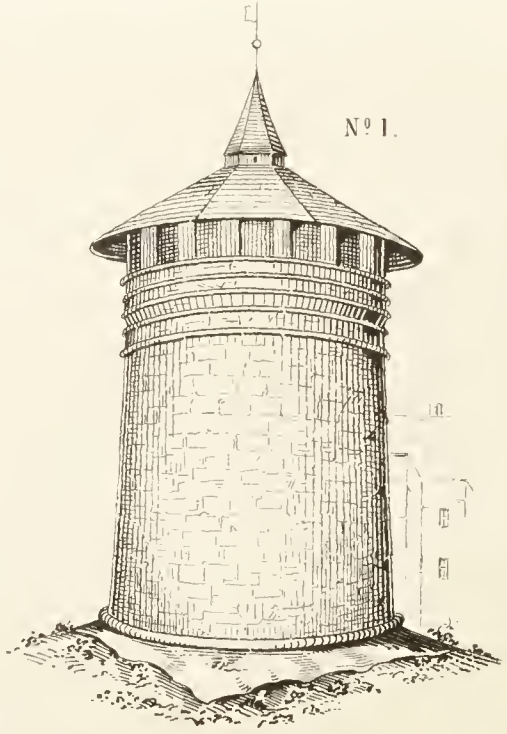
With the general resemblance which the history of Nuremberg bears to that of Venice there is this difference,

that the degradation and decay were not so complete. The national character never fell so low as at Venice, and even at the present day, there is a primitive simplicity and heartiness about all classes of people in Nuremberg, which has greatly disappeared in most parts of Germany. Nor are the costumes of the lower orders much altered since the days of Albert Dürer. The men still wear their wide hanging coats, huge steel buttons, and shovel hats; and the women, attired in gay scarlet petticoats trimmed with velvet, and a stiff black head-dress glittering with brilliants, may yet be seen proceeding to and from the public fountains with the long narrow "Wasserbutte," or pail for water, strapped to their shoulders.

Nuremberg in her palmy days, attained about an equal share of eminence in the three fine arts: in painting she had her Albert Dürer, in sculpture her Adam Kraft, and if the names connected with the earlier period of her architecture have not been handed down to us, it is but the usual fate of the architects of the middle ages to be forgotten, while the monuments of their genius live. Georg and Fritz Rupprecht however, and Conrad Roritzer, are still remembered in connection with the Frauenkirche, Schöne Brunnen, and Lorenzokirche.

Nuremberg first became a walled town in the latter part of the thirteenth century. Of the old walls few vestiges remain, except two narrow and lofty gate towers, now in the middle of the town. A century later the city had so greatly extended, that it was found necessary to enclose a much larger area, and the present walls were built, coinciding with the old only where they take within their circuit the ancient Burg. Along these walls are a succession of small bastions, also numberless little square feudal towers with high pitched roofs, sometimes ridged,

PLATE I.



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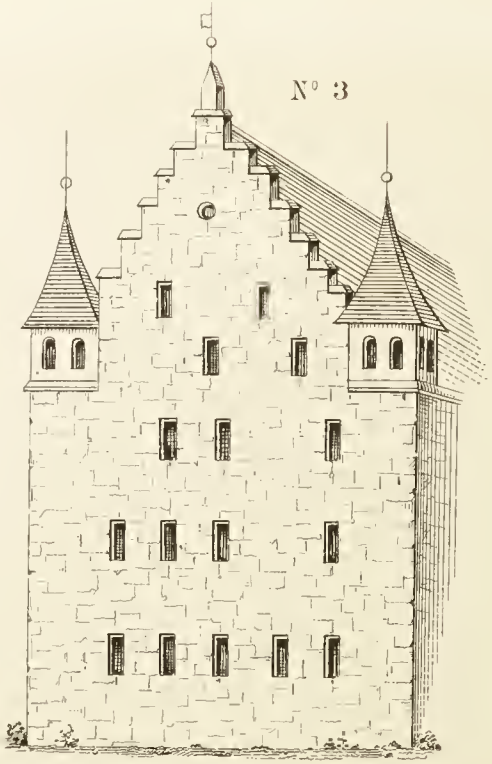

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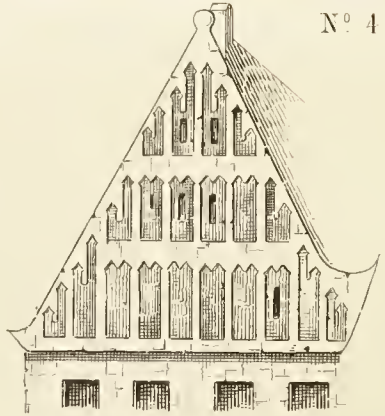

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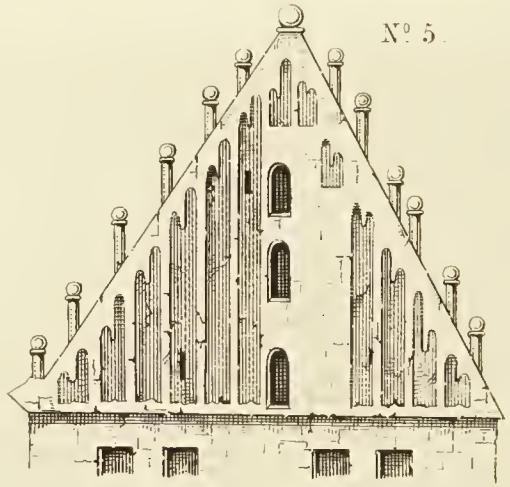

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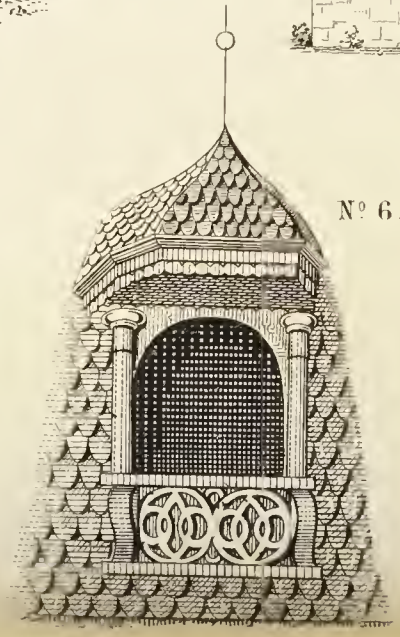

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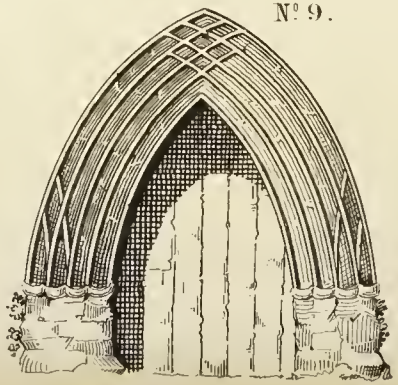

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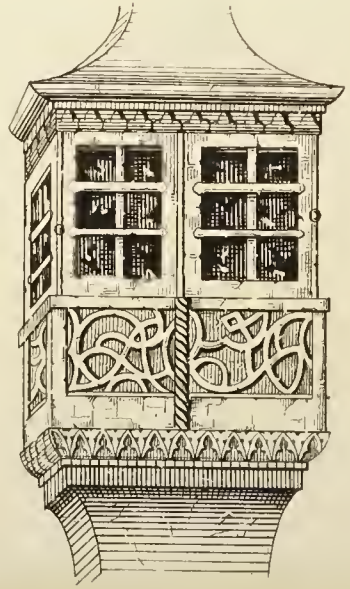

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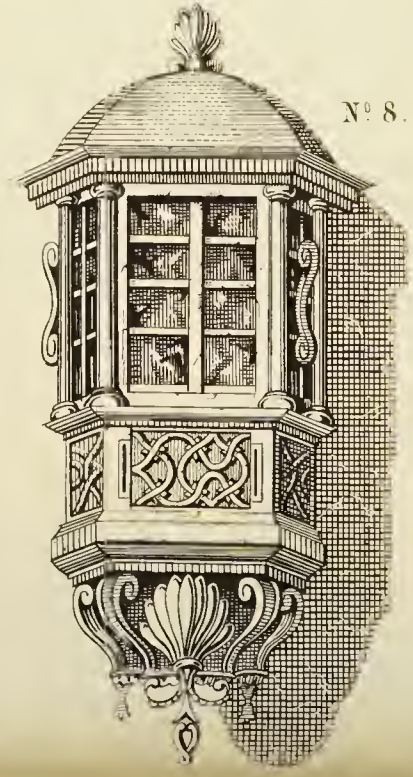


Nº 8.

sometimes pyramidal, all of these towers possessing a general character, yet no two being exactly alike. Some of them have attached to each corner a conical-capped little turret, like that of a Scottish baronial mansion; others, particularly those on each side of the gates, project outwards on the side farthest from the town. In consequence of the continually recurring contentions with the Burggraf already alluded to, the citizens found it necessary to separate themselves from him by a wall, and built in the vicinity of the Burg a lofty and most imposing tower, capped by a slender tapering spire with round open turrets at the angles. At a much later period (about 1560) the Nurembergers further strengthened the defences of their city, by building a large cylindrical tower of most peculiar form, close to each of the four principal gates. These towers, which constitute one of the most characteristic and picturesque features of Nuremberg, are of a broad substantial shape, tapering slightly as they ascend. On the upper part are a few bold round mouldings like the hoops of a barrel, and a flattish conical roof is crowned by a lantern turret with loopholes. One of them is represented in Plate I. fig. 1. These defences in former days rendered Nuremberg impregnable, but much as they now add to her beauty, they would be of little avail against modern artillery. Since the stirring times of the Thirty Years' War, the moat has grown up into a fruit-garden, and the walls, bastions, and towers, covered with shrubs, creepers, and mosses, have lost their original asperity of outline.

The *Burg* or *Reichsveste* occupies an abruptly rising eminence just within the walls of Nuremberg. This fortress consists of a congeries of buildings of different dates, from the eleventh century, or perhaps earlier, down to the

fifteenth. To the five-cornered tower has been assigned a date long prior to Conrad the Salic; and certainly the under part has much the appearance of Roman masonry. Next in antiquity, and probably of Conrad's time, is a four-storeyed square tower looking down towards the town. Its machicolations, formed of semicircular notches, are Romanesque; but certain rude statues built into the walls, popularly believed to be relics of Pagan times, have acquired for it the name of *Heidenthurm* or Heathen tower. I shall presently revert to the remarkable chapels within its walls. The part of the Burg next in date is the so-called *Kaiserstallung* or Imperial stable, equally a misnomer with the Heidenthurm. It was built in 1494 as a public granary, on the site of the dwelling of the Burggraf which had been razed in 1417. The round tower with the fire watch, occupying the highest point, is contemporary with the remarkable gate towers already described, and of similar form, but considerably more slender and not quite so lofty. This is the most prominent object in all distant views of Nuremberg, and its masonry being of immense solidity, and its site the most elevated in the town, it is facetiously said by the Nurembergers to be at once thicker and thinner, higher and lower than the gate towers. An irregular mass of building, surrounding a courtyard adjoining the Heidenthurm, and dating in its present form from the fifteenth century, was in more recent times the imperial dwelling; and here it is that the King of Bavaria has his state apartments, which, however, he but rarely visits. This part of the Burg is as little like a royal residence as possible, and one is startled by its close proximity to that beer-drinking resort, the Schlosszwinger. On entering by a gate on which the two-headed eagle of the empire is conspicuously displayed, the first object that meets the

cye is a large linden trcc with an cnormously thick trunk. Four centurics have passed since the youths and maidens of Nuremberg were merrily dancing under the shade of that selfsame trec, then a venerable linden of 300 years old, to celebrate thc marriage-day of Philip Pirckheimer, the father of Albert Dürer's friend Willibald; and on the selfsame day Dürer informs us, that his own father, then but a youth, having left his native home in Hungary, arrived in Nurcmberg to try his fortune in that great city of commcrce and art. This vcncrable tree, which is still green and flourishing, was, cven in Dürer's time, known by pre-eminence as the "Grosse Linden." The interior of the court has rather more pretension than the outside would lead onc to expect; and a large hall, adorned with paintings of the Nuremberg school, conducts to an oratory. A stair communicating with both thesc rooms, gives access to the upper chapel of the Heidenthurm.

Having now in a gencral way described the Walls and the Citadel, I shall consider separately, first the Ecclesiastical, and then the Civil and Domestic Architecture of Nuremberg.

The carliest ecclesiastical architecture of Germany is exceedingly beautiful. Its immediate parent, the Lombard style of Italy, arose gradually from the combination of three several elements. The reconquest of Italy by Justinian introduced the architecture of Byzantium, which first appeared at his new capital, Ravenna, and gradually amalgamating with the native Roman basilica, spread over the north of Italy. It was introduced into Germany towards the close of the eighth century, by Charlemagne, who brought with him a company of Italian freemasons, when he established his northern capital at Cologne. The church of St. Vitale at Ravenna, was adopted as the model for his

celebrated chapel at Aix, which in the course of time was followed by a multitude of churches of singular beauty at Cologne, and all along the banks of the Rhine, in some of which the Byzantine, in others the Roman element preponderated, the dramatic spirit of the Teuton, and the necessities of the climate, giving rise to gradual modifications of the Italian type, more particularly a greater steepness of roof, and a profusion of towers and spires. The Lombard architecture of the Rhineland spread gradually to the other parts of Germany. The cathedral of Bamberg is one of its most glorious developments, and Ratisbon possesses more than one church built after the early Cologne model.

The now existing specimens of Romanesque architecture in Nuremberg present various singularities, and exhibit a semi-oriental character, the origin of which must be sought for in the Crusades and the constant intercourse with Venice, where the influence of the Arab school of architecture is more marked than any where else in Europe.

The two chapels of the Burg have been already alluded to. According to a practice not unfrequent in feudal castles, they are built one above the other, the upper chapel being intended for the Seigneur, and the lower for his retainers.

The *Margarethenkapelle*, the lower of the two, is probably of the original date of the castle. It is in the form of a parallelogram, and has a nave and aisles, with round arches supported by thick short pillars, four square and four round, with singular capitals; the carvings on one representing eagles, on another lions' heads, while two are ornamented with stiff foliage, somewhat like the Corinthian. But the most striking feature of these capitals is the immense depth of their abacus. It is as deep as the bell, and consists of two parts, a plain tile below, and what

almost gives the idea of a second convex bell and abacus superimposed on it. On the plinths and on the capitals of the square pillars, is a running ornament, something like the guilloche.

The *Ottmarskapelle*, or Imperial Chapel, is situated immediately above the chapel of the retainers, to which it is probably not much inferior in antiquity. It is approached, as we have already seen, from the inner court of the Burg by a spiral staircase, which leads into a vestibule, vaulted with round arches, supported on two short round massive pillars. Their capitals exaggerate the peculiarities of those in the lower chapel, giving still more markedly the impression of one capital superimposed on another. The central member of the abacus and the archivolt are carved with reticulated work. In the one capital the carvings on the bell are of the same sort of Corinthian foliage which we found in the chapel below; in the other, they represent masks or grotesque heads. The chapel to which this vestibule leads is divided into a nave and two aisles by slight and lofty marble columns, perhaps the spoil of some old Italian temple, whose capitals present a medley of rather well-cut eagles, masks, and extravagant foliation.

Nuremberg formerly possessed, in the Egidienkirche, a large church in the Romanesque style; it was, however, unfortunately consumed by fire in 1690, two chapels alone surviving the general wreck. One of these, the *Eucharius-kapelle*, exhibits most beautiful and somewhat irregular transitional architecture, with still more decided traces of Arabic influence than the chapels in the Burg. It must surely have been built at least a century later than 1147, the date of the Scottish Benedictine foundation to which the church belonged. Three rows of not very massive round pillars divide this chapel into two aisles, and sup-

port the pointed vaulting of the roof. The capitals of these pillars, differing in detail, have a sufficiently marked general character; one of them is represented in Plate I. fig. 2. The abacus, with numerous deeply cut mouldings, is nearly twice the height of the bell, and the latter, both in form and ornamentation, is thoroughly oriental. The Arabesques are carved at once with boldness and delicacy. The mouldings of the base are almost a repetition of those of the abacus, with foot ornaments.

The two principal churches in Nuremberg, dedicated respectively to St. Sebald and St. Lawrence, and standing the one on the north and the other on the south side of the Pegnitz, are beautiful monuments of German Gothic architecture. From the length of time which elapsed between the beginning and the completion of these edifices, we have in them an opportunity of tracing the architecture of Nuremberg in its early progress, its maturity, and its decline.

St. Sebald was begun in the late Romanesque or transitional epoch, and concluded in the richest style of late German gothic. The west front, including the lower part of the two towers, and the semi-octagonal apse between them, known as the Löffelholz chapel, and forming the peculiarly German feature of a western choir, were the earliest built. We have in the original elevation the round arch every where, the horizontal division into stories, and the wallplate of semicircular notches characteristic of the Romanesque of Germany; but on the introduction of the new style, the façade received certain modifications in accordance with it. The round windows were superseded by pointed, the two on the second storey of the apse being converted into one, and the pitch of the roof was raised to facilitate the introduction of pointed vaulting. The towers were also

completed and surmounted by bold and simple spires, shooting up to a height of 256 feet above the pavement. In the upper part of the Löffelholz chapel is a vaulted chamber, unseen from beneath, called the *Engelschor* or Angels' Choir, originally to be a gallery for the singers. Underneath the apse is a crypt, in which the round arched vaulting remains.

The nave belongs to the earliest Gothic. Its roof is on a level with that of the Engelschor, and the vaulting shafts which sustain it are massive quadrangular piers, with a round shaft on each unattached side, resting either on the capital of a plain round pillar, or on the corbel, terminating in the canopy to a statue. The clearstorey windows are small and roundheaded, and there is a triforium arcade of pointed arches, formed by short frequently recurring columns. The piers of the nave are not as in later churches, set diagonally. Their capitals are widely different from the early English. The abacus is square, with a variety of mouldings on the lower side (round abaci rarely occur in Germany); and the bell, instead of being deeply undercut as in the corresponding style of our own country, has a gracefully and gently curved outline, which partaking more of the convex than the concave form, invites the eye to rest on its carvings. These for the most part consist of somewhat formal patterns of lotus leaves, intermingled with wreaths of pearls. There are some of later date, in which graceful natural foliage takes the place of the more conventional ornamentation. The bases are more deeply channeled than is usual in early English work; in fact some of them have the fissure common in France, which gives the unpleasant appearance of separation into two parts.

The aisles belong to a later period than the nave, and so also does the choir, begun in 1361. The middle of the

fourteenth century may be considered the culminating point of German Gothic. Later edifices, though exquisitely beauful and highly decorated, generally exhibit some tokens of debasement. In this choir we have a peculiarly German symptom of degeneracy. Its central and side aisles are similar both in height and breadth, in consequence of which there is no clearstorey, and the whole is covered by one highly pitched roof, which rises to such a height as quite to overpower the nave in a distant view. This peculiarity of construction is very frequent in late German Gothic.

Turning to the interior, we soon discover another irregularity; the choir is not exactly on a line with the nave, but tends most perceptibly towards the north, while the seven sides of a polygon which terminate it, are neither of equal size nor even symmetrical. This irregularity is probably accidental, arising from the strangely inaccurate measuring instruments of the time; but the modern Germans, in their anxiety to discover symbolism every where, have persuaded themselves that this arrangement has been adopted to express the received tradition, that the Saviour's head, while on the cross, inclined to the right side.

The aisles run all round the east side of the choir and its polygonal apse, this being accomplished by an alternation of triangles and parallelograms in the vaulting. The piers are placed lozengeways, rounded at the angles, and have a shaft attached to each side: they exhibit another unmistakeable trace of degeneracy, the absence of capitals, or what Professor Willis calls the discontinuous impost. The windows occupy nearly the whole height of the walls. Their tracery is geometrical, but wants altogether the gracefulness of the tracery of France, and of those early German churches which exhibit more of the French influence. Old Nurem-

berg took the lead in glass-painting as well as other arts; and there is in this church glass varying in date from the "Ecce homo" of 1274, to the latest and most gorgeous specimens by Veit Hirschvogel.

Returning to the outside of the choir, we find that from the basement, which begins immediately below the windows, all ornament is excluded. Above the basement storey, however, the buttresses luxuriate in rich and graceful tabernacle work; their crocketed pinnacles rising to a considerable height above the wall which they support. The windows are externally enriched with delicate shafts, whose capitals carry little gables or canopies. The heads of these gablets have, much to the disfigurement of the church, been cut away and superseded by the present horizontal line of the roof.

There are two doors on the north side of the church, one leading into the nave, the other to the choir, with two corresponding to them on the south side. Of these the most remarkable is the northern door, opening on the choir, or more properly on the junction of the nave and choir, distinguished by its rich tracery, and called the *Brautthür* (bride's door); because, according to the ancient German practice, the bride and bridegroom stood beneath its shelter to receive *outside* the church the nuptial benediction. Statues of the Virgin and St. Sebald, the latter with his pilgrim's staff and a model of the church, occupy the sides of the porch, and underneath it are ranged on either side, figures of the wise and foolish virgins, in the early Nuremberg style, with much tenderness of expression and boldly flowing drapery.

The other door leading to the north aisle, is known as the *Anschreibsthür*, from the custom which existed when a death occurred, of inscribing on it the name of the

deceased. In the tympanum are spirited reliefs relating to the death of the Virgin. Above the south door opposite, is a representation of the Last Judgment, in which Emperors, Popes, and Jews are seized and chained by thoroughly Teutonic demons. The capitals of this doorway are ornamented with grotesque monsters, intended to serve the twofold purpose of scaring away evil spirits, and gently satirizing the besetting sins of the ecclesiastics. The Sybils occupy a similar position on the capitals of the *Anschreibsthür*.

It would be wandering from the subject of this paper to notice further the numerous sculptures with which this church is adorned; but I cannot forbear mentioning two noble works of that prince of German sculptors, Adam Kraft, in which it is difficult to know whether most to admire the union of consummate freedom of design with minuteness of detail, or the air of vitality which the genius of the sculptor has imparted to his New Testament characters, investing them with the costumes and accessaries of Nuremberg citizens of the fifteenth century. I refer to two high reliefs, one representing the Last Judgment, and the other (in a protected recess at the east end) the Burial of the Saviour.

A stranger will be surprised with the unmutilated state of the works of art in this and the other churches of Nuremberg. On my first visit to the Sebalduskirche, what with uninjured statues and pictures, the shrine of St. Sebald, and the candles lighted on the altar, I could hardly realize the interior to be that of a Lutheran Protestant church. The cause of this must be sought in the history of Nuremberg. This town, warmly embracing the tenets of the Reformers, had at the same time no share in the iconoclasm which elsewhere disgraced the Protestant

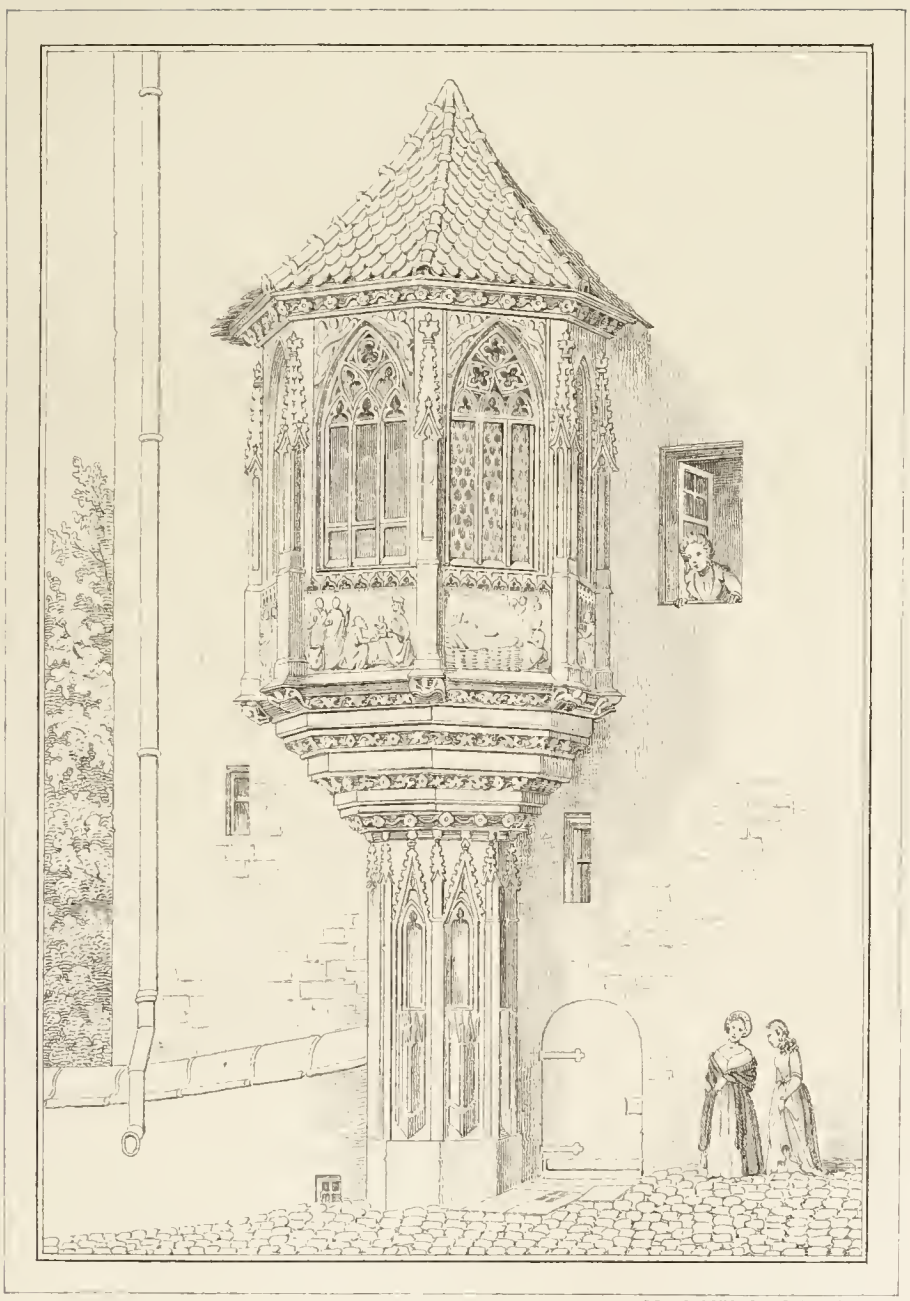
cause. The Reformation in Nuremberg was not the work of a lawless mob, who, while attacking the corruptions of the Church of Rome, thought it necessary also to wage war against those arts which humanize and elevate the mind. On the other hand, many of the greatest geniuses who adorned the fine arts in Nuremberg and the adjacent towns, were attached to the Reformers and their cause, and several of them made use of their pencil to aid in promoting the reformed doctrines. Albert Dürer was Melancthon's intimate friend, while Lucas Kranach, a warm adherent of Luther's, aided in bringing about his marriage with Katharine Bora, and executed a series of woodcuts to illustrate Luther's bible. Hence it arose, that when Nuremberg shook off the jurisdiction of Rome, her churches were not subjected to the wholesale demolition perpetrated in other places. Hirschvogel's gorgeous windows, the sculptures of Kraft, and the wood carvings of Veit Stoss, still exist in all their integrity, as also Peter Vischer's masterwork in bronze, occupying the centre of the choir, the shrine of the saint to whom the church is dedicated. This marvel of Nuremberg art consists of a canopy of light rich Gothic, most elaborate in detail, comprising powerful and expressive representations of the twelve apostles. It was executed in the end of the fifteenth century, to contain the sarcophagus of the saint who introduced Christianity into Franconia; and round the coffin are bas-reliefs representing various miracles which he performed during his wanderings. We see him miraculously replenishing a jug with wine, rescuing a man whom the earth was in the act of swallowing up for disbelieving the truth of the doctrines which he promulgated, and making an icicle blaze up one wintry day when his entertainer churlishly refused him fuel.

I cannot leave the neighbourhood of the Sebalduskirche without describing the glorious Gothic oriel of the parsonage. It is represented in Plate II.,* and consists of five sides of an octagon, connected by a series of mouldings with an octagonal pier resting on the ground and recessed in niches. To each angle of this oriel is attached a square pier resting on an angel, and terminating in a crocketed pinnacle. The pointed windows have two mullions and geometrical tracery, and in the field below them are represented in bas-relief five events from the life of the Virgin — the Annunciation, the Conception, the Offering of the Kings, her Death and Assumption. The parsonage was rebuilt in 1513 by Melchior Pfinzing, a canon of St. Sebald's church, and secretary to the Emperor Maximilian, who sitting in the recess of this oriel, whose panes are now adorned with his portrait, composed his "Tewrdanck," a poem recording that emperor's marriage with Mary of Burgundy. This oriel may be looked on as the perfection of Nuremberg Gothic of the best period, and makes us deeply regret the loss of the building of which it originally formed part.

The limits of the present paper will not allow me to describe so fully as I would desire, the church of St. Lawrence, which, more advanced in style, surpasses St. Sebald, both in beauties and in faults. Its west front and nave belong to the latter half of the thirteenth century; but the choir was not completed till the year 1477. The front has two square towers, each surmounted by an octagonal storey, from which a spire flanked with gables rises. The spire to the north was built in 1285, the other,

* Plates II. III. IV. V. and VI. are most successful reproductions in lithograph, of some of the excellent series of Etchings published by Schzag at Nuremberg.

PLATE II



Scheuck & Mc Farlane, Lith^rs Edinburgh.

ORIEL. St SEBALD'S PARSONAGE.

similar in outline, but devoid of all ornament, as late as the beginning of the fifteenth century. The part of the front intervening between the two towers is divided into three stages: the uppermost, the gable of the nave, presents a network of windows, separated by rich but chaste architectural ornament, and a turret with a pinnacle in the centre: the middle stage is taken up with one of the most exquisite rose windows in Germany; and the lowest is occupied by the principal doorway of the church, no less than 50 feet in height, with enriched spandrils, adorned with such a profusion of excellent bas-reliefs, as is I believe unrivalled. One cannot but contrast this wide lofty portal with the diminutive doors which are to be found in the greatest cathedrals of England, whose paltriness is in vain sought to be redeemed by prominence of drip-stone and depth of moulding. In the centre, between the double doors, a slender shaft with a strangely irregular but richly foliated capital, supports the Virgin and Child. In the recess of the doorway, on each side, are Adam and Eve, and further in, two other figures with scrolls, as if announcing the mysteries of religion to our first parents. Above, in the outer curve of the arch, are the Prophets, and in the inner curve, the Apostles, as revealing to mankind the events of the Saviour's life, which fill both the tympanum of the great doorway and the tympana of each separate door, the uppermost compartment representing Christ as Judge. In these sculptures, which have been referred to as early a date as 1278, the traditional compositions of Italy are to a certain extent adopted, and there is a gracefulness of attitude and drapery reminding us of the south. The German feeling, though very discernible, is not so fully developed as in the age of Adam Kraft.

The square towers are surmounted with beautiful parapets, and divided into seven stages by strings, with the arched corbeltable of German Romanesque, only that the arches are pointed, not round as at St. Sebald's.

Looking at this church externally *en masse*, the same peculiarity at once meets the eye which we encountered at St. Sebald's, the immense height of the choir and prominence of the undivided roof which covers it, corresponding as we shall see to a similar internal structure.

Entering by the great doorway, we find the nave is twice as broad and twice as high as its aisles. The flying buttresses which support it are internal, forming a series of little chapels, and are only seen outside where they protrude in arches above the roof of the aisles. The choir belongs to a later date than that of St. Sebald, having been begun in 1439, and ended as late as 1477: it is rich in ornamentation, and exhibits not a little of that studied display of constructive skill and dexterity of workmanship which mars the later German Gothic. The choir, as at St. Sebald's, is of the same height with its aisles, but double their breadth, all these being considerably loftier than the nave. The aisle is carried round the east end, under precisely the same alternation of triangular and quadrangular vaults as at St. Sebald's. The piers have the discontinuous impost: they are not placed diagonally, though those of the nave are, and the vaulting of the choir is exceedingly flat, but has a complicated network of ribs, forming geometrical patterns, which, as hiding the real construction, is not altogether pleasing to the cultivated eye. The only possible apology for the practice, frequent in Germany in the fifteenth century, of raising the side aisles to the same height as the central, is the opportunity afforded for a gorgeous display of coloured

glass in windows nearly the whole height of the wall. Here, however, no such palliation can be admitted, as there are two storeys of windows in the aisles of the choir. These windows are filled with gorgeous painted glass, most of them displaying the arms of the patrician families of Nuremberg; and one, what is known in England as a Jesse window, that is, a genealogy of the Saviour from Jesse, in which the figures of the members of the pedigree are attached to the branches and leaves of a tree, which has Jesse for its root. The donor has placed, beside the Jewish kings and fathers, his own likeness, and that of the different members of his family kneeling, with the various saints whose names they bore. The traceries exhibit markedly the characteristic failing of the late German style — an anxiety to display ingenuity at the expense of that constructive simplicity which is essential to beauty. We have already seen the necessary concentration of vertical support done away with, in order to astonish the eye with the discontinuous impost; and here, similarly, while in the former styles the tracery bars were always contrived to strengthen, or to appear to strengthen the window, we have this constructive beauty sacrificed for the sake of startling and unexpected forms, whose "point and value," as quaintly expresssed by Mr. Ruskin,* "consists principally in turning the features of good traceries upside down, and cutting them in two, where they are properly continuous."

Of the many works of art in the Lorenzokirche, all are thrown into the shade by the *Sakramentshäuslein*, or receptacle for the host, which though not required in Lutheran worship, still adorns the north side of the choir. This tabernacle is the chef d'œuvre of Adam Kraft's genius,

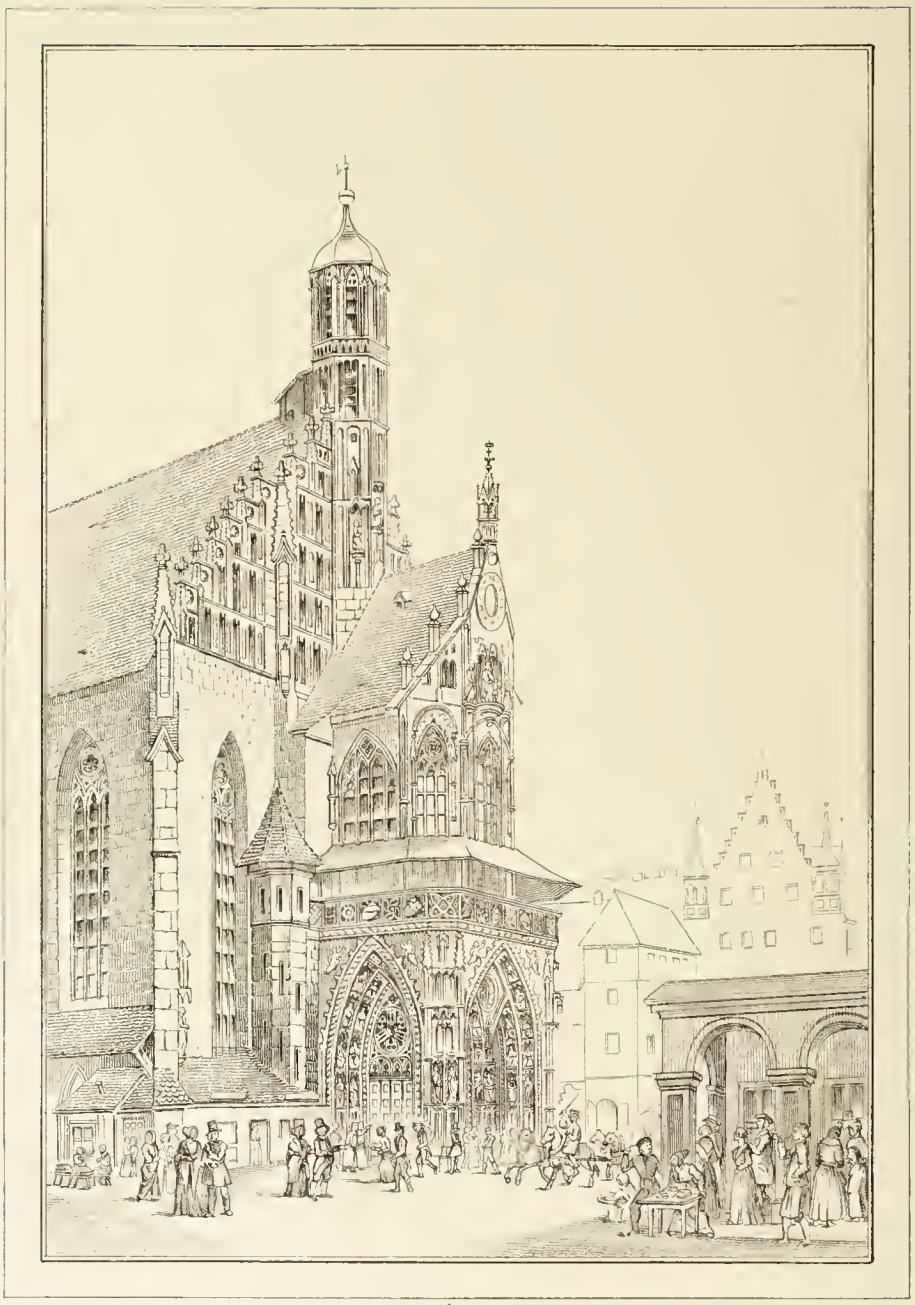
* "Stones of Venice," vol. i. p. 185.

and perhaps the most graceful work which mediæval sculpture has produced. It shoots up to a height of 60 feet, from a platform supported by figures of the sculptor and his apprentices in a kneeling posture, then gradually contracting, resolves itself into the most delicate and complicate details of foliage and statuary, till suddenly arrested in its upward growth by the arch under which it stands, it bends itself as a plant might do, and dies away in a graceful spiral curve.

The two churches just described are fair specimens of Gothic Architecture as it prevailed in the parts of Germany more remote from French influence. The façade of the Lorenzokirche exhibits the style in its greatest beauty, and the choir of the same church in its decadence. Pointed Architecture was an exotic in Germany, which, transplanted from France, never became so thoroughly naturalized as the style which it superseded. The earlier Gothic churches on the banks of the Rhine do not differ very materially from the French model; but in the fifteenth century, particularly in south and east Germany, there is an obvious departure from the original type, and the Germans, endeavouring to strike out a path for themselves, show that they have never thoroughly comprehended the beauties of the style which they professed to copy. In skilful workmanship, on the other hand, the Germans surpassed the French, and this is especially the case in Nuremberg, where there is a nervous vigour about the minutest details, which, aided by an energetic and original school of sculpture, renders the Gothic of Nuremberg far more attractive than much that is more faultless in ecclesiastical architecture.

There are a variety of less important churches, which the limits of this paper forbid me to describe. The fast decaying Carthusian Abbey, built in the close of the four-

PLATE III.



Schenck & Mc Farlane, Lith.rs Edinburgh

FRAUENKIRCHE

teenth century, and now desecrated as a cavalry store-house, is worthy of the study of any lover of Architecture, particularly the cloisters.

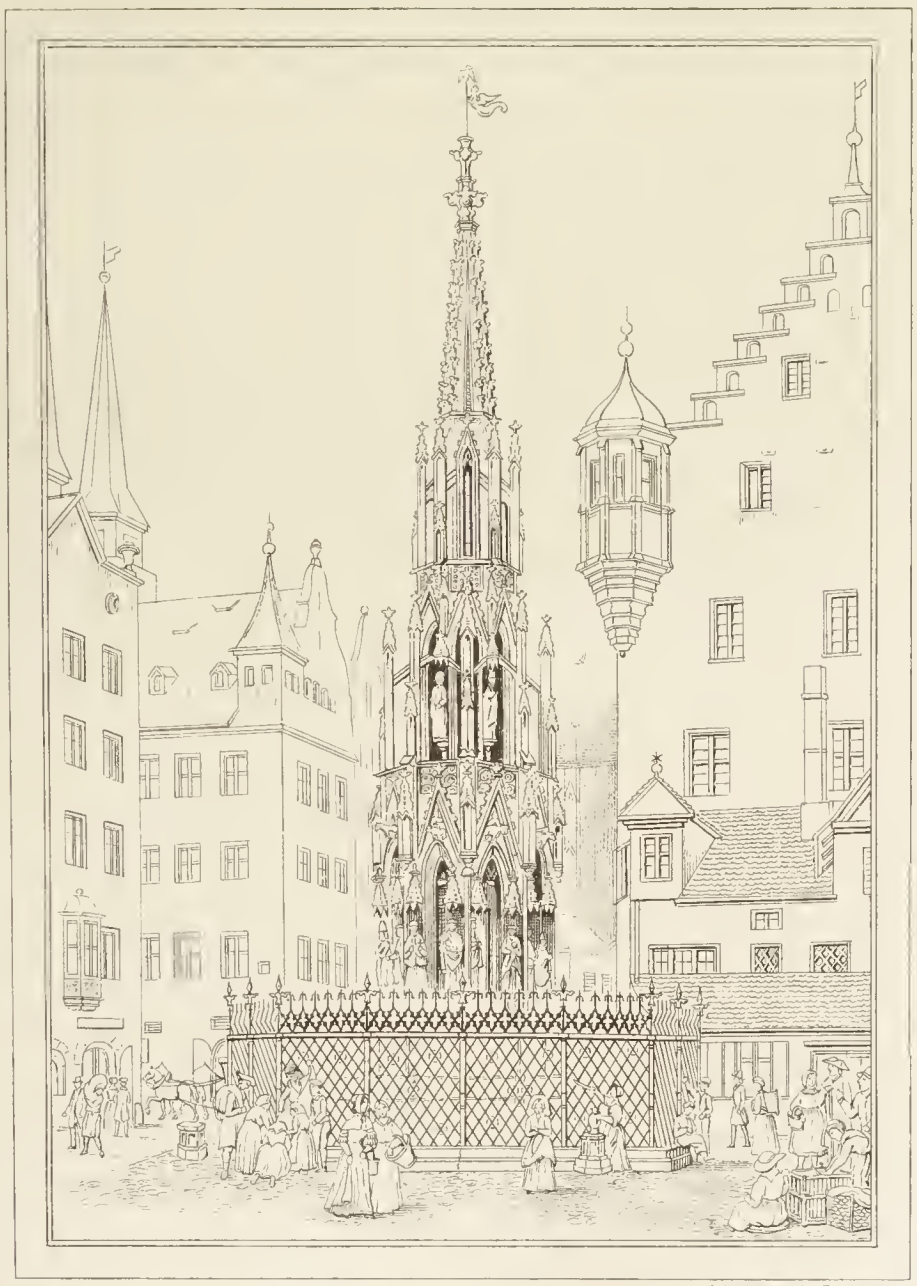
The Frauenkirche, the church now occupied by the Roman Catholics, deserves a fuller notice: it was built after the designs of the brothers Rupprecht, between 1355 and 1368, and intended by Charles IV. for the imperial chapel. It is to the façade only (Plate III.) that I mean to call your attention, as an unusually enriched specimen of a description of ornamentation so characteristic of Nuremberg, that it meets the eye at almost every turn of every street. The chapel, with the clock which surmounts the porch, is an after addition, designed by Adam Kraft, so that in its original state we have the lower part of the façade studiously plain and unadorned, all the richly carved sculptures and decorations being reserved for the gable and the porch. The gable is divided into stages by horizontal strings, below which a wall-plate of pointed arches with cusps descends at every second arch in a pilaster, and the pilasters extend upwards in an unbroken vertical line and terminate in pinnacles above the gable, the sides of which ascend in steps, pierced with quatrefoils. The pilasters themselves have also niched recesses, whose pointed heads are on a line with the arches of the wall-plate. A somewhat similar style of decoration characterizes the octagonal tower attached to the face of the gable which originally terminated in a spire.

Over the porch is a parapet of light open work, decorated with armorial bearings, and the doorway has been enriched by Schonhofer with sculptures suggested probably by those of St. Lorenzo. The Virgin being patron of the church, her intercession is the principal subject. She sits enthroned as queen of heaven between the two doors, and

an angel with a lily on either side. Adam and Eve occupy the same places as in the Lorenzokirche, and stretching upward along the recesses of the arch are the prophets and patriarchs, whose regard is however here fixed on the Virgin.

Passing from the subject of Ecclesiastical to Civil Architecture, the elaborate spire of the fountain, known throughout Germany by pre-eminence as the "Schöne Brunnen," first claims our notice as one of the finest existing applications of Gothic Architecture to secular purposes. This justly famed Brunnen, standing at the corner of the market place, opposite the Frauenkirche, is the subject of Plate IV. It rises from a wide octagonal basin, and consists, besides the basement, of three diminishing octagonal stories of open work, supported by flying buttresses, and terminated in a slender spire. The sides of the second storey are set across the angles of the first, and its buttresses, placed not at its angles, but facing each side, give support to the angles by branching off into two ogee arches. Under canopies between the buttresses, are statues by Schonhofer, formerly gilded, which unite breadth of handling with the utmost tenderness of expression and poetic feeling. This breadth is particularly remarkable in the treatment of the hair and drapery. The statues on the lower storey, sixteen in number, are arranged in pairs, and represent the seven electors and nine heroes, viz. — Charlemagne, Godfrey of Bouillon, Clovis, Joshua, David, Judas Maccabæus, Julius Cæsar, Alexander, and Hector; an odd assemblage of Christians, Jews and heathens. Of these, Charlemagne and Judas Maccabæus are the best, and several of the others are only restorations. Moses and seven prophets occupy the second storey. The whole luxuriates in the most exuberant ornamentation; yet so united and harmonized,

PLATE IV.



Schenck & M.c Farlane Lith.r Edinburgh

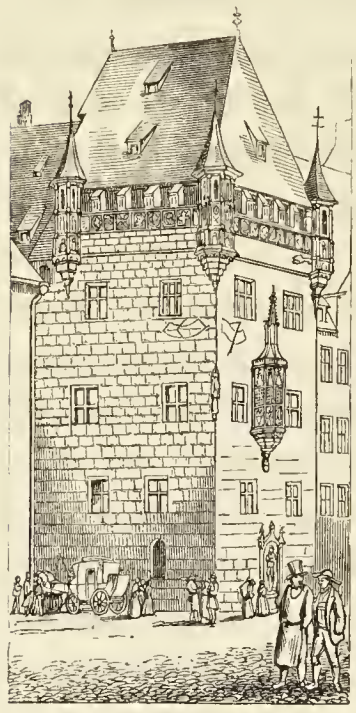
THE SCHOENE BRUNNEN

that nothing seems superfluous. Well may Nuremberg be proud of having given birth to Georg and Fritz Rupprecht, whose combined genius designed this monument. We cannot wonder that the possessors of such a fountain have enshrined it among their *penates*, and that every evening towards sunset, the maidens of Nuremberg are seen wending their way to the Schöne Brunnen, each accompanied by her "Schatz," or lover, who aids her in the task of filling her "Wasserbutte," the beautiful fountain thus becoming, like the wells of olden time, a rallying point of news, gossip, and scandal.

The spacious market-place whereon this Brunnen stands, was in ancient times the Judenstadt, or Jews' quarter of the town. On the breaking out of the plague in 1349, popular belief traced the origin of that fearful malady to the Jews, who had settled here in multitudes, and the strange accusation was preferred against them of poisoning the public wells. This was the beginning of a system of relentless persecution, which ended in the expulsion of the Hebrew race and the destruction of their houses and their synagogue, the Frauenkirche being built on the site of the latter. The advantage in point of space acquired by the removal of the Judenstadt, has to a certain extent been lost again by the erection of a row of unsightly market booths, in such a situation as considerably to obstruct the view of the Frauenkirche and the Schöne Brunnen; but we may hope, that the justifiable pride with which the Nurembergers regard their old city, will yet lead some public spirited individuals among them to unite in buying up these obnoxious erections.

Replete as Nuremberg is with the domestic architecture of the middle ages, comparatively few dwelling-houses are extant of an older date than the fifteenth century. This principally arises from the limited use of stone in private

houses during the early periods of Nuremberg's history; but we have one noble example of a private dwelling of stone contemporary with the Frauenkirche and the Schöne Brunnen; I mean the so-called Nassauer Haus, the corner house opposite the Lorenzokirche, represented in the subjoined woodcut. It was built by the family of Schlüszelfelder, about the year 1350 or 1360; such at least is the opinion of the best informed Nuremberg antiquaries, though an earlier date has been assigned to it. It has four lofty storeys, undivided by string-courses; the windows are placed with tolerable regularity, and those in the upper storey were originally pointed. A beautiful semi-octagonal oriel, with reliefs from the life of the Virgin, occupies the central part of one of the walls, and to each of the upper angles of the building is attached a hexagonal or octagonal turret pierced with trifoliated apertures. The walls are crowned with an embattled parapet, and the armorial bearings of the electors and of the town of Ratisbon are carved immediately below the merlons, on a tablet which runs round the turrets. If we except a little sculptured figure of an angel, with a corbel and canopy attached to the corner of the house, the whole ornament is confined to the turrets, parapet, and oriel, the rest of the wall being studiously plain.



In point of size and pretensions, however, there can be no doubt that the Nassau House was entirely exceptional. The other early houses, even of the principal Nuremberg citizens, were homely and unambitious. They were built of

a framework of timber, with the interstices filled up with brick. As space was precious in a walled town, the streets were narrow, and each ascending storey was made to project beyond that below it, till the opposite houses approached so as almost to exclude the light. Albert Dürer's house is a late example of this species of architecture. In the earlier houses of this description, the roofs, always steep, generally project over the gable, and have an *inward angle*—a most characteristic and picturesque feature of the domestic architecture of Germany. A gable is often truncated and finished off by a sloping roof. Still there are no timber-beam houses so quaintly constructed, or elaborately carved, as may be met with in Hanover, Münden, Hildburghausen, and many other towns in North Germany. In comparison with other old German towns, we rather remark the absence of this description of architecture, the people of Nuremberg having begun at an earlier period to build their houses of stone.

I have already said, that the old Nuremberg citizens, in constructing their dwellings, studied comfort rather than ostentation. In the spirit of the "Lamp of Sacrifice," whatever they had that was costly or precious, was dedicated to the service of the Church; and that not because it was useful or necessary for religious worship, but simply because it was costly or precious. In their private habitations, works of high art would generally have been thought out of place; what was principally aimed at being the useful and the appropriate. Yet there was no marked difference in style between ecclesiastical and domestic architecture. The same habits of thought, the same taste, and the same constructive skill, which we admire in buildings dedicated to sacred purposes, were exhibited in the simple habitation of the simple citizen. The head and the hand of the artist were to be traced in all the minutiæ of household decoration, in the

forms of tables and chairs, of doors, locks, and knockers. An angular niche was often filled by a figure of the Madonna or a saint.

As stone comes into use as a building material, the features of Nuremberg Architecture become more distinctive and characteristic. The houses are generally deep and narrow in front, and the gables often, though not uniformly, turned to the street. Specimens of gables may be seen in Plate I. p. 51, figs. 3, 4, 5. Some of them ascend in steps; others are divided by horizontal strings and vertical pilasters, connected by pointed or straight-sided arches, like the façade of the Frauenkirche, with or without pinnacles. Sometimes the horizontal divisions are altogether wanting. This species of ornamentation is always confined to the gable proper; I know no instance of its extending below the eaves. At a later period, round shafts, with a ball resting on their capital, often take the place of the pilasters and arches. Sometimes these shafts terminate abruptly in corbels; at other times the corner shafts are carried down to the ground: in short, there is an infinite variety in the ornamentation of Nuremberg gables.

As a general rule, the surface of the wall becomes more broken as it ascends, and the windows more numerous. The roofs, always acutely pitched, are covered with red tiles of the pointed shape common in Germany, and time has imparted to them a mellow brown tinge. These roofs luxuriate in combinations of fantastic turrets and dormer windows, the latter often occurring in tiers one above another; but a species of dormer, represented in Plate I. fig. 6, deserves separate notice. I do not know whether English architects would allow it to be a dormer window, as in fact it is not a window at all; but in Germany it is included under the same general term, "Erker." It rises on a line with the wall; the sill or

tablet between its aperture and the roof, is in general riehly carved, and the aperture itself unglazed. A canopy, often mueh ornamented, projeets into the street, to which a pulley is attaehed, for the purpose of drawing up the wood used for fuel. There is hardly a house in Nuremberg but has one of these Erker; and simple as the eontrivanee seems, it is by no means generally prevalent in other parts of Germany. The earved sill or tablet, is not peculiar to this deseription of Erker; it is universal in dormers, turrets, and oriels. In one very beautiful Erker within the eourt of the house now oecupied as the "Blaue Glocke" hotel, the earving has for its subject a figure reeumbent in death, with the emblems of mortality around. Saered subjeets, espeeially from the life of the Virgin, are more usual; but the most prevalent of all deeorations for sills eonsists in traeery bars, interwoven in curves and foliated at the interseetion. The turrets attached to the eorners of the gables are generally square or polygonal, not circular. They sometimes projeet forward like their eounterparts in Scotland. We have already seen such in the Nassau House; at other times their sides are on a line with the wall. The pyramidal eaps of the turrets and dormers have generally the inward angle above alluded to, and their points and ridges are crowned with every variety of spikes, balls, erosses, and gilt stars, giving a grotesque and animated look to the whole roof. Oriel windows are as universal as "Erker"—there is hardly a house but has one projeeting from its wall. Many houses have several, and they oeeur in any storey of a house, and at the most irregular intervals. These oriels have generally a good deal of earving about them; some are purely Gothie in eharaeter —most partake eonsiderably of the Renaissanee, but are, notwithstanding extremely beautiful. Two speeimens are represented in Plate I. figs. 7, 8. Plates of traeery often

occur as external decorations between the storeys of a house; these are, in the Rathhaus, beautifully combined with an ornamental arcade. Flatheaded, pointed, round, and trefoil-headed windows, all occur pointed, more generally in the upper storey, and we have often groups of twos and threes. Some remarkable windows of this kind occur in the Kaiserstallung, in the heads of which the round arch is interwoven with the trifoliated.

A somewhat unique kind of archivolt decoration sometimes occurs above pointed doorways, consisting of interlacing bars parallel to the sides of the arch. A beautiful specimen may be seen in the Rathhaus. Plate I. fig. 9, is an example taken from the Kaiserstallung.

Let it be further remarked, that no two gables, no two dormers or turrets, and no two oriels are exactly alike. The architecture of Nuremberg was the true offspring of uncontrolled thought and feeling, which could never be contented to repeat itself.

Passing from the exterior to the interior of a Nuremberg dwelling, the great doorway conducts us into a quadrangle, beyond which there is sometimes a second court, communicating with another street. Many of the internal arrangements resemble those of the Venetian palaces. The lower storeys of the merchants' houses were reserved for their counting-rooms and their goods, above them were the apartments occupied by the family, not so lofty in the roof as those of Italy, but with massive and often beautifully carved panelling and Mosaic floors. Much room is taken up with stairs, of which each house has several: these are most frequently spiral, often open at the sides, and supported by arches beneath, and their rails, whether of stone or wood, elaborately ornamented. Open galleries run round each storey, forming the communication between the different

apartments; and these, always elegant in form, are often adorned with the most grotesque and spirited carvings.

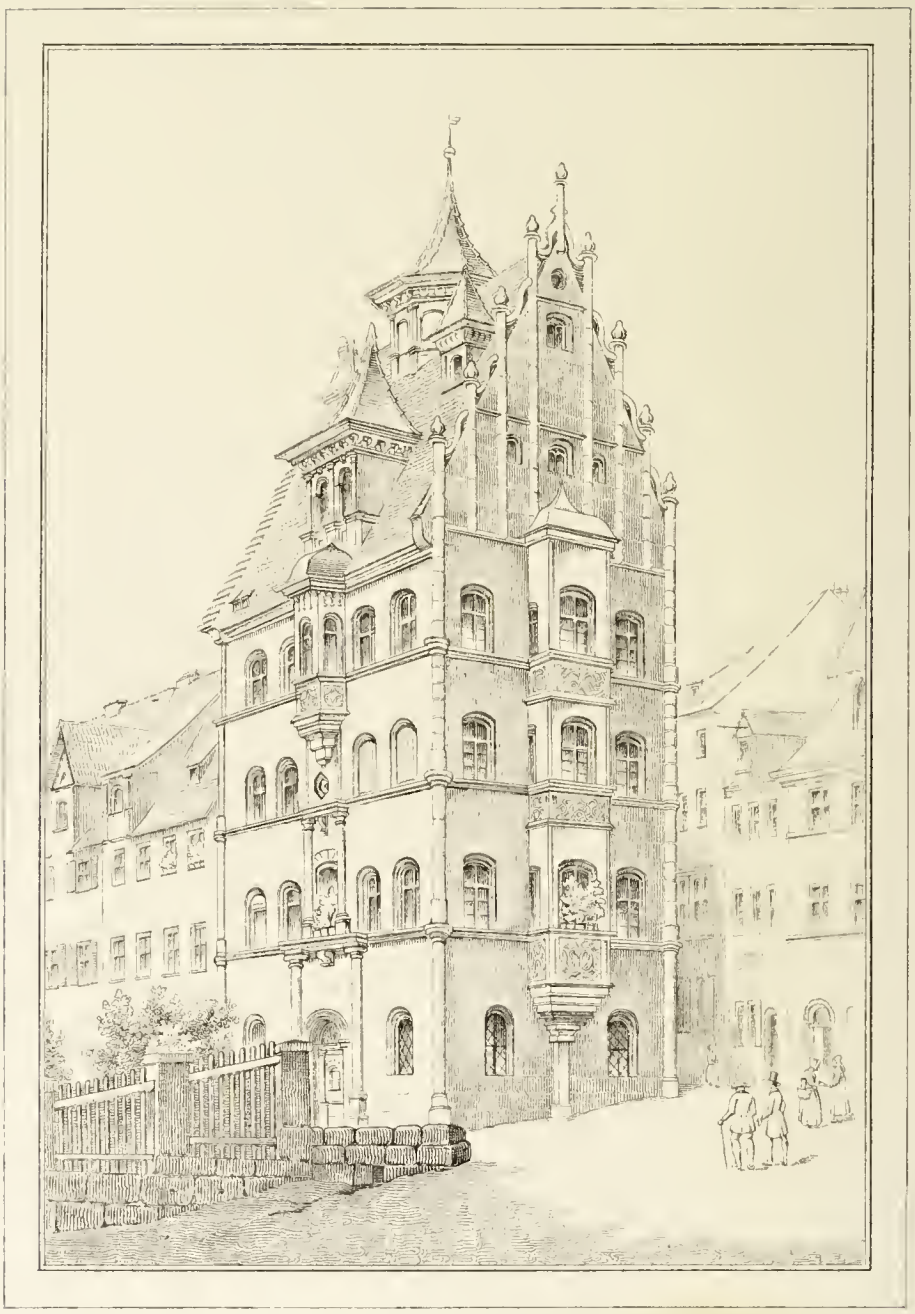
But with the introduction of luxury among the citizens came the blight of the Renaissance, and by slow and gradual steps it stole on the architecture of Nuremberg. Sculpture, divorced from architecture, had allied itself with the art of painting, which in the sixteenth century attained its climax. Architecture, deprived of the aid of the sister art, and already in a declining state, succumbed to the sinister influence much sooner than did painting. Albert Dürer never willingly yielded to it. Whenever he transgressed (as in the Triumphal Car of Maximilian in the Rathhaus) it was in opposition to his better judgment and feelings, and at the solicitation of one of his friends or patrons who had attached himself to the new school. The whole tendencies of this movement were repugnant to Dürer's nature. A carved window sill in the Winklerstrasse, executed from a design of Dürer's, is a curious illustration of this. The curves of the tracery are graceful, daring, and energetic. We see the soul of the great artist in them; but around them, to suit the taste of the owner, is a border of diseased cornucopias and other Italian monstrosities, which not even Dürer's genius has been able to invest with one particle of life.

Still the progress of classicalism in the heart of Germany was not so rapid as to the south of the Alps. The German energy of former days was not extinct, and though the new and corrupt forms mixed themselves up with the old, a considerable amount of beauty and vitality continued for a time to subsist in domestic architecture, which cannot be looked on as thoroughly dead till the breaking out of the Thirty Years' War. We trace the first symptoms of the Renaissance in a house in the Hirschelgasse, built by Lorenzo Tucher, representative of one of the most powerful patrician

families in Nuremberg, and descendant of Hans Tucher, who in conjunction with Karl Holzschuher, was the first citizen who enjoyed the dignity of "Losunger" or republican dictator. This house was begun in 1533, and completed in 1544. It has now so far fallen from its glory, as to be occupied by an ingenious manufacturer of papier maché, one of the minor branches of the arts in which Nuremberg "Witz" is endeavouring to reassert its old pre-eminence. Herr Fleischmann, whose manufacture is itself well worthy of a visit, is equally gratified to exhibit to strangers the curious specimens of his skill, and the nooks and corners of his house. The front, turned towards the street, exhibits Adam and Eve, and some of those Christian symbols which were beginning to wear out of use. There is a uniformity, savouring of poverty of invention, in the position of the square-headed windows: they have massive drip-stones, not however bending outwards as in English Elizabethan architecture, but terminating half way down in corbels. The strings which partition the house into three storeys are crossed at intervals by vertical shafts, with beautifully finished capitals, which rest on corbels representing angels and saints. These shafts were meant to carry statues, but the niches recessed for them have never been filled. The gable is decorated with round shafts rising from corbels, and extending in pinnacles above the roof. The tower, containing the principal stair, is circular, not polygonal, the usual form in earlier times, and by the side of it are two little round projecting turrets. The large hall has elaborate panellings, beautiful tapestries, and in the windows some good painted glass.

As we advance into the sixteenth century, the houses begin to lose somewhat of their broken outline; curved forms, particularly the ogee and cyma recta, take the place

PLATE V.



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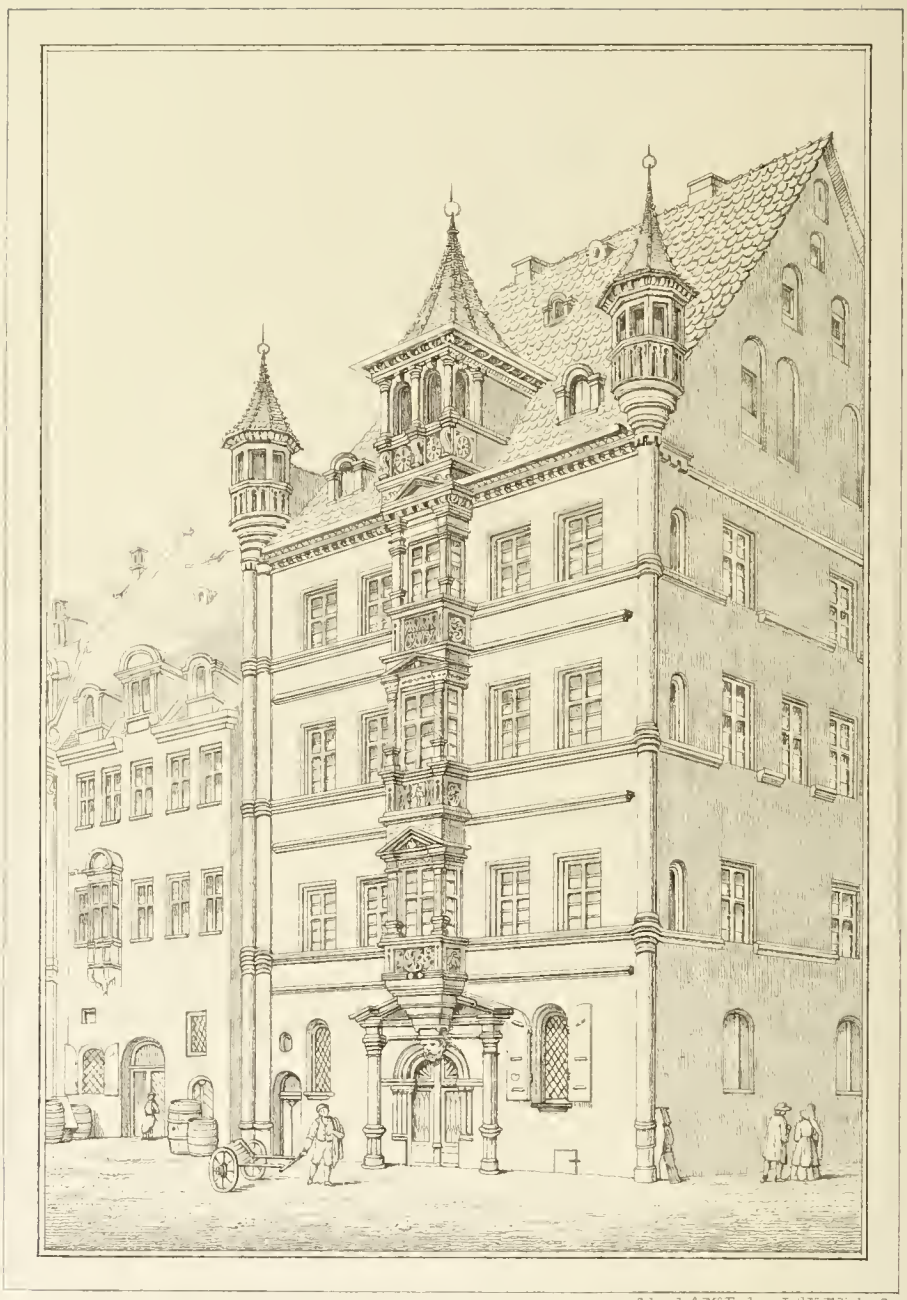
DWELLINGHOUSE PELLER'SCHE PLATZ.

PLATE VI



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DWELLINGHOUSE, ADLERSTRASSE.

of the bold acutely pointed roof. The oriels, no longer carelessly and fearlessly protruded anywhere, according to the fancy of the moment are made to occupy the central position, and there are two or more of them, one above another, of a uniform pattern, sometimes extending down the whole side of a house. One instance of this may be seen in the gable wall, represented in Plate V. where three such superimposed oriels communicate with the ground by a pillar, and are surmounted by a Renaissance capping. Various other examples will be found among the aristocratic mansions of the Adlerstrasse. I particularize but one (represented in Plate VI.) in which the Gothic and classical elements are strangely jumbled together, yet not without a certain degree of pleasing effect. At each angle is an octagonal turret of the old fashion, from which a round shaft descends to the ground, terminating in a thoroughly Gothic base. The storeys are divided by strings, which are carried in bands round these shafts. So far we have a Gothic front, but down the middle of it is a suite of oriels, one above another, in each of which Gothic shafts support a classical pediment, the whole being surmounted by a dormer of thoroughly Gothic character, but with three Renaissance brackets supporting its shafts. The lowest of the oriels terminates beneath in a mask at the head of the round arched doorway, which latter is furnished with a porch, wherein two banded Gothic pillars sustain a classical pediment. This vertical line of dormers, oriels, and porches, divides the front into two equal portions, of which the one is the precise counterpart of the other. The most scrupulous regularity is also preserved in the arrangement of the windows.

One more Nuremberg house and I have done. We have reached the beginning of the seventeenth century, when revived classicism had long reigned supreme in Italy, and

had nearly attained its climax throughout northern Europe. As a specimen of the mansion of a Nuremberg patrician of that date, I shall take the Pellersche Haus in the Egidienplatz. The front bears a few lingering traces of the old architecture, all but overpowered in the struggle with the new. St. Martin sharing his cloak with the beggar, is allowed to adorn the second storey, though cast into the shade by Jupiter, who, with his crown, his sceptre, his thunderbolt, and his eagle, stands on the summit. The gable is cut up by frizzled scrolls, and a half circle is taken out of each side, in the most approved Italian fashion. An abortive attempt at tracery, and two or three pyramidal roofs look as much out of their place as St. Martin himself. Within the court we see no further attempt to keep up the pretence of Gothic Architecture. All reminds us of Venice; not however of the real glories of Venice, but of her later palaces. Every thing is gorgeous. A spiral stair, enriched in the most costly manner, leads to a saloon, profusely decorated with elaborate carvings in oak. With all this there is nothing markedly offensive to good taste, yet one cannot help feeling, that the architect had attempted to make up by splendour and show for the want of an instinctive feeling of beauty.

I have several times alluded to the *Rathhaus*, and one would naturally expect to find in Nuremberg a town hall in some degree worthy of the first city of the empire. But alas, with the exception of a few beautiful fragments, the Rathhaus of former days has disappeared; on its site we have a Tuscan palace, erected in 1616, whose façade however, presents none of the glaring outrages on taste current at that period, and on the whole reflects credit on its designer, Karl Holzschuher, a member of one of those families which, from an early period in the annals of Nuremberg, have produced men of eminence in a variety of departments.

Still this Italian elevation looks sadly out of place where it stands, ranged against the choir end of St. Sebald's church, and on entering the quadrangle, or walking round to the Rathhaus-gasse, and contemplating what of the old structure has been preserved, one cannot but regret deeply the loss of the rest. The great hall, 80 feet in length, with its barrel-vaulted roof, and its walls adorned by Dürer's pencil, has undergone such extensive alterations, that the old citizens would hardly recognize its identity.

The Thirty Years' War broke out before the Rathhaus was completed, and during the succeeding century, when Nuremberg was harassed with foes without and dissensions within, comparatively few new houses were erected. The old Egidienkirche was burnt down in 1690; and that any thing like taste had vanished from the city of Albert Dürer is too plainly proved by the monstrosity which, in 1716, usurped its place. The exterior, with its unsightly towers, and their caps, its brackets, its pillars, and its pediments, is only exceeded in offensiveness by the interior — an array of scrolls and ornaments of the most hideous and unsightly forms that ever were devised. Either from its shape, or from its congregation, being the most fashionable in Nuremberg, this new Egidienkirche is generally known as the "Kleiderschrank" or wardrobe.

Up to the accession of the late and still living king of Bavaria, there is nothing further to chronicle. Lewis, the greatest royal patron of the fine arts since the days of the Medici, immediately took in hand to prevent the further destruction and mutilation of Nuremberg. A society was formed, under his auspices, for the preservation of monuments of ancient art; and while useful regulations were made to enforce the keeping of old houses in repair, there was at least an attempt on the part of those who planned the

new to revive the old Nuremberg style. Among the earlier specimens of modern Nuremberg Gothic, too much of an anxious adherence to the mere form of the old style may be detected, and even in some instances an ostentatious display of its quaint and curious ornaments in inappropriate positions — witness the interlacing bars of the old Rathhaus repeated above the arch of the Bamberg railway station. But the later attempts are freer of this mannerism. Reindel and Heideloff have shown, that it is possible to build in the style of the old Germans without sinking into servile copyism; to adhere to the spirit of the ancient builders, without losing sight of the requirements of the nineteenth century.

I have in this rapid survey kept you within the walls of Old Nuremberg; but this is not because the district around is devoid of architectural interest. The Nuremberg nobles had their castles or country seats, as well as their town residences, and these Schlösser still stud the country for some distance off, though many of them have been dismantled, and others have passed into new hands since the breaking out of the Thirty Years' War. The plan of these castles is various; but for the most part they have a square tower at each angle, forming a line with the walls of the building. Moats and ramparts, with round towers, were also indispensable as a protection in the days of the Knight of Gailingen and the other robber nobles. The village houses have high pitched roofs, and are built of a framework of timber, filled in with brick or stone. There is often much beauty and intricacy in the geometrical patterns in which the beams are arranged. The little country churches have generally an octagonal tower and spire in the centre, and the chancel end higher than the nave. Altogether, except perhaps in the Salzkammergut, I have never seen villages more picturesque

than those of Franconia. Farther off, following the course of the Pegnitz, are three little decaying towns, onee dependencies of Nuremberg, with quaint old walls, houses, and towers. Lauf, Hersbruck, and Velden, have all been places of strength in their time, and the beautifully lying Velden in particular, was most successfully defended by a gallant body of men during the Thirty Years' War. The romantic upper valley of the Pegnitz being away from post roads, is as untrod by the tourist as the wilds of Siberia, yet easy enough of access to any one prepared to rough it a little, and travel either on foot or in the rude carriole of the country.

This sketch, imperfect both from the necessary limits of a paper read in this Institute, and from the fragmentary state of my own knowledge, is the result of a residence of about six weeks in Nuremberg. Though much engrossed with the attractions offered by the sister arts, I devoted a considerable time to the arehitectural antiquities, which increased in interest on me day by day; and on quitting Nuremberg, I found that much as I had seen, a greal deal remained unexplored. Strange it is, that while Venice, Rouen, and other mediæval cities of France and Italy are daily visited by our artists and amateurs, the old towns of central Germany, and more especially Nuremberg, should be so completely neglected. I would recommend to any lover of architecture who has a little spare time at command, to take a run over to the banks of the Pegnitz, and settle himself for a month under the comfortable roof of Mr. Hess, the excellent landlord of the Wittelsbacher Hof. I can promise that he will find abundance of delightful occupation for that period. While Venicc is but the ghost of herself, Nuremberg, in externals at least, is still in some measure the Nuremberg of former days. I have seen an engraving of Nuremberg three hundred years old, which in all its essential

features might stand for Nuremberg of the nineteenth century. The old citizens and nobles still survive in their descendants. Go where you will in Nuremberg, every step brings you into contact with times gone by. Accompany me to the grass-grown Egidien Platz, and you will find a group of the largest of the ancient patrician residences standing as formerly in all the pride of civic aristocracy. Among them are the ancestral mansions of the Pirckheimers, the Behaims, and the Holzschuhers, all still occupied by the representatives of these families. Within the Holzschuher House is Albert Dürer's famous portrait of Jerome Holzschuher, with features precisely the counterpart of those familiar to the eye in the person of Jerome's lineal descendant. The old church in the centre of the Platz alone is gone — the church where worshipped the Paumgärtners, Pirckheimers, and Holzschuhers of old, for which the "Kleiderschrank" is, alas, a poor substitute. If you require to consult books or maps, or wish other assistance in the prosecution of your researches, you have only to go to the Stadt Bibliothek, where a stranger will meet with every possible aid and courtesy from the librarian; and at the "Germanische Museum" also, much interesting information may be acquired.

Transactions of the Architectural Institute of Scotland,
Session 1855-56.

No. III.

ON THE PRINCIPLE OF USEFULNESS

AS A

GOVERNING FEATURE IN THE ARCHITECTURE

OF THE

ANCIENTS.

BY

PATRICK ALLAN FRASER, Esq.

OF HOSPITALFIELD, ARBROATH.

[*Read at a Meeting of the Institute in Edinburgh, held on 4th February* 1856.]

Although it cannot be denied, that during the last few years, we have had better signs of real progress in architectural science, than when the world was treated only with learned disquisitions and curious conjectures regarding the origin, comparative proportion, and consequent beauty of the five orders — with antiquarian research in the fruitless endeavour to fathom the perplexing mystery hanging over the introduction of the pointed arch, and with vain attempts to discover when this or that Gothic moulding, and this or that foliated Gothic ornament first emanated from the creative genius of a creative period — I think the importance

of adhering strictly to the ancient practice of using constructive forms only when and where required for useful purposes, has not been sufficiently dwelt upon; and as I most sincerely believe, were we to follow ancient example, and use columns, arches, entablatures, and pediments, only when necessary for useful construction, we should sooner arrive at excellence in architectural design. I have come here, not seeking to amuse you with evidence in favour of or against the Egyptian or the Greek origin of the Doric column; nor to consider whether the Corinthian capital was suggested by that accidental occurrence, romantically associated with the untimely death of a Greek maiden, or grew out of the sportive exuberance of tutored invention; nor whether the Caryatides owe their existence to the promptings of vindictive or devotional feeling; but having carefully considered the subject, to state to you freely those reasons which have induced me to believe, that the great difference between ancient and modern Architecture, and the great hindrance to our improvement in architectural practice, will be found in our almost total disregard of that which constituted the controlling principle in olden times, viz. — USEFULNESS.

When the Egyptian architect designed his column in imitation of the palm tree, and ornamented it with representations of the lotos and the papyrus, did he do so that he might place it against a wall—an idle decorative feature? No; he invented that form for useful purposes—as a support for the roof of his temple, and also to serve as an imperishable record of the doings of his sovereign, thereby adding another volume to the written history of his country. When ancient Grecian architects constructed temples, did they erect columns to support idle architraves, friezes, and cornices, or construct the latter to shade and shelter stereotyped conventional carvings, in no way associated with the

purposes of the building? No; porticoes, colonnades, and pediments being in their time necessarily required, they used columns and entablatures for useful construction, and designed projecting cornices to shelter and shade sculptures associated with the heathen worship — *the purpose of the building.* They constructed pediments, not only to aid in the formation of roofs, but to suit the requirements of a people, commanded by their laws, and impelled by their religious feelings, to record with the iron pen of the sculptor the history of their heroes and their devotion to their deities. They placed their temples — the habitations of their gods — above the surface of the surrounding ground, not as we do, *purely for effect,* but in accordance with their sense of devotional duty. Thus every act had a consistent object — every form a useful purpose; and the fitness of individual parts commands our admiration no less than that grandeur and beauty of the whole as shadowed down to us in history. Equally guided by useful considerations were ancient Gothic architects. Amid all the wonderful and unwearying variety of their works no idle form found a place. Every arch, every column, and every corbel, were truthfully necessary, and so used by those who, conscious of their creative power, sought not the aid of that truthless copyism which has always, wherever practised, led to the ruin of true constructive science. Thus the Romans, when they borrowed the forms of Grecian art for merely decorative purposes, failed to seize the genius of invention, and under the guidance of plagiarism, were led to construct edifices, the remains of which still testify to the truth of the proposition for which I am here to contend — that Architecture, to become great, must be useful and truthful. Our instinctive love of ornament will naturally create a desire for decoration, but constructive forms cannot, consistently with the true character of con-

structive science, be used for idle ornamentation. Architecture, when so treated, does not rise above the level of an imitative or scenic art. Lest this assertion should lead you to misunderstand the drift of this paper, however, I must state, before proceeding farther, that my object is not to find fault with the use of ornament, nor to blame the making of individual features as ornamental as these can be made, consistently with their fitness for constructive duties, but to the practice of copying and using ancient *useful forms* for *entirely useless purposes;* and while I thus endeavour to explain my views, I beg you will bear with me, and understand I do not desire offensively to dictate, but simply to direct your attention, and entreat your serious consideration to what I believe to be the difference between the Architecture of ancient and modern times. Should I be found wrong in the estimate I have formed of this difference, I shall gladly admit my error. At the same time, while I say this, I must in candour tell you, I do not at this moment feel that I am wrong. If I had had any doubts on the subject, I should certainly have remained at home until I had, at least to my own satisfaction, removed them. Therefore, being thus strongly impressed with the notion of being in the right, I trust you will not expect I should, merely to save myself from the charge of dogmatism, every now and then apologize for unhesitatingly stating my opinions; more especially as I understand, the main object of our meeting here is, that we may be heard fairly while expressing freely our individual ideas concerning Architecture.

The consideration of usefulness as a controlling principle, appears to me to be as necessary to the architect as is the study of nature to the painter. He who makes an elevation according to rules, regardless of the useful requirements of a building, and afterwards arranges the interior accommoda-

tion to suit the exterior design, is no more likely to become a truly great architect than he who paints without consulting nature can be other than a manufacturer of conventionalisms in painting. I assert farther, that it is not more difficult for a painter to represent nature truthfully than for an architect to combine grandeur, variety, and quaint beauty of form with useful accommodation and perfect consistency between exterior and interior design. I do not mean by this, however, that a house ought to have indicated on the exterior every feature of the interior arrangement; but that no attempt should be made to produce variety or beauty of design by useless excrescences, no matter what forms such excrescences assume, whether that of buttresses, turrets, or balconies; in short, no form for which a useful constructive necessity cannot be shown ought to appear. And I venture to say, were architects to consider it reconcileable with professional dignity to show a reasonable necessity — a fitness for useful purposes for each and every form they construct, we should have less difficulty than we now have in arriving at a true knowledge of their respective merits; for I believe, unless a man is possessed of rare constructive talents, combined with a feeling for the beautiful in form, he cannot be an architect in a true sense. Any person possessing ordinary capabilities, may decorate that which would otherwise be a plain building by arranging copies of one or of all the five orders; and by assorting slavish imitations of Gothic features, he may live to fill a whole district with Gothic-masked castles, cathedrals, and parish churches; but to use those ancient forms properly, that is, only when and where required for useful purposes, must be the work of a mind beyond mediocrity. As well might we expect to make a man a poet and a novelist, by setting him for three or four years to copy the works of Sir Walter Scott,

as that any young man, taken from school, and made to copy *copies* of ancient buildings for three or four years, will at the expiry of his apprenticeship be qualified to perform the duties of an architect. Yet we do think so; at least, we act as if we really believed nothing more were necessary than thus acquiring a knowledge of the handwriting of the art, and going through this copying ceremony.

Still we do not profess to consider Architecture a copying trade. We theorize about it as being a pursuit far beyond and above the control of common sense. In theory, we cannot bring ourselves to connect Architecture with house building, I mean, we appear to consider the art of designing edifices degraded in proportion as it becomes associated with useful accommodation. We have got fixed ideas regarding the fixed proportions of the five orders, and somewhat vague notions concerning Gothic-clustered columns, arches, and corbels, and seem to believe the art of arranging those forms either picturesquely or classically, irrespective of constructive necessity, the paramount duty of an architect. We appear to view lath and plaster groined arches, that spring from off lath and plaster corbels, successful and meritorious efforts of constructive genius; and notwithstanding we are fully aware that Gothic forms owe not their characteristic excellence to any adherence to the like arbitrary rules as those which govern Grecian design, we measure and mould every old example, and award praise to Gothic architects (modern so-called) according to the extent of similitude their columns and the contour of their mouldings bear to ancient models.

Farther, by way of showing that consistency between exterior forms and interior requirements occupies but little of our attention, do we not consider an oblong building, having a line of purely ornamental columns placed on each side, and a useless portico adorning each end, a noble ex-

ample of original constructive Architecture in the Grecian style?

When about to build a house, we somehow or other appear as if we considered ourselves barely entitled to have an opinion of our own. We cannot divest ourselves of the feeling, that we must implicitly follow certain rules, drawn from some previously existing style, and that these rules must regulate and control the extent of accommodation. We dare not suppose that a building ought to be suited to its purposes, instead of these being made subservient to the style of the house. In short, we cannot imagine that noble Architecture can possibly result from useful considerations, or in other words, why a building strictly useful should be the work of an *educated* architect. We will consider the carrying out of utilitarian ideas the province of the mason and the carpenter, and seem most religiously to believe were we to do otherwise, we should, as Rickman says in the introduction to his work, "be much in danger of having our public edifices debased by a consideration of what is convenient as a house rather than what is correct as an architectural design." Acting in this belief, we decorate the exterior of our buildings with useless columns, and construct solid turrets, useless parapets, unusable balconies, useless gables, imitation doors and windows, useless roofs, useless chimney-tops, and project beyond solid walls solid gurgoyles, and make all these and many more entirely useless forms, lest we should debase the art by any consideration for what is convenient; all the while overlooking the fact, that each and all of those idle imitations had useful prototypes, which owed their existence solely to that serious consideration given by ancient designers to what would be "convenient as a house," as well as "correct as an architectural design." Are we not strangely inconsistent in this matter of house build-

ing? As archæologists, actively occupied in seeking for a meaning in every old stone, thereby virtually declaring, that in ancient times, usefulness was the vital principle of constructive science, while as architects we are zealous in ignoring that principle. We construct costly and useless plagiarisms in stone and wood, and mask plain brick mansions with compo-columns, empty pediments, rustic corners, architraves, friezes and cornices, and after crowning all these merely plaster doings with long lines of utterly useless balustrading, we direct the attention of the world exultingly to such, as cheering evidences of our vast progress in constructive art. Neither does our inconsistency appear less in modern Ecclesiastical Architecture, for, notwithstanding all public processions in connection with the Church of Rome are prohibited by law, the whole face of this country is now being studded over with imitations of Romish churches, in open disregard of the requirements of the Protestant service. Even old churches are being altered, or I ought perhaps to say *restored*, ostensibly that these may more closely resemble a form of building, manifestly ill-suited for the reformed worship. Old comfortable pews are being torn out, open benches or stalls substituted, and book boards made inconveniently narrow. Yet it cannot be said that we experienced inconvenience while occupying old pews, or were incommoded by the breadth of former book boards, or that we love our ease in church less, or are one degree less exclusive than were our forefathers. Nor can any one say that these alterations and imitations of ancient churches result from our changed requirements in any respect, farther than that a mania for architectural plagiarism has grown up among those who act as if they believed they would be able to compel others to care more for religious truth by simply surrounding them with futile imitations of Gothic art. I

fear they will not suceeed. The ancient eathedral was the effect, not the eause of devotional feeling. But were our arehiteets to give up slavishly eopying and using aneient forms, unless where those are suited for present requirements, we should in all probability have ehurehes made quite as ornamental and better adapted to the reformed serviee; for eould they only resolve to pay striet attention to fitness, the power of making useful forms ornamental would very speedily be attained. Of this praetice and its results we may see evidenee even in Naval Arehiteeture. Our shipbuilders employ their talents in devising forms demanded by useful eonsiderations, and do they not show themselves eapable of produeing beautiful forms? Again in Architeeture eonneeted with Civil Engineering, we may find many instanees where the same results have followed like considerations. The Bell Roek Lighthouse is one example belonging to this elass of design. And this leads me to offer a remark in eonneetion with this example, on the vast differenee between the aneient praetice of repeating previously existing forms so as to serve for purposes similar to those that may have suggested their original eonstruetion, and the present unmeaning habit of copying aneient forms regardless of fitness. When Stevenson adopted the Eddystone Lighthouse as his model for that whieh he plaeed on the Bell Roek, he did not do so merely that the form might please the eye, but because an earnest attention to fitness had eonvineed him he eould not well devise a better form. And in so doing, he aeted preeisely as did those arehiteets of old, who, by having earefully studied the requirements of their times, gave to their works that sameness of eharaeter we now eall style. Yet those aneient designers were not plagiarists in the present sense of the term. For instanee, although our old eastles have one general or leading

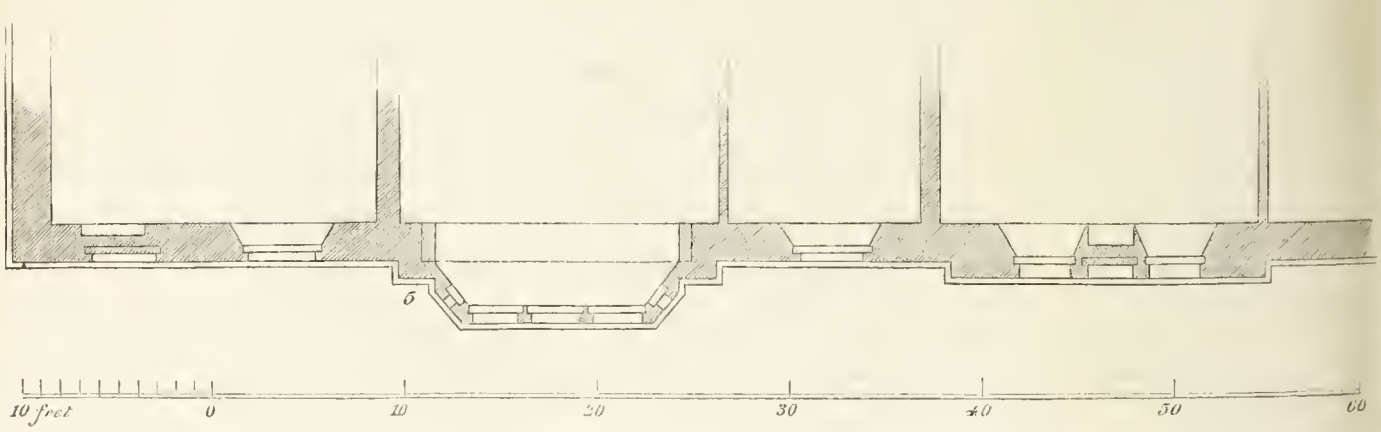
form, evidently suggested by the usages of feudal times, the slightest examination of the remains of those buildings will suffice to prove, that great skill in original design had been seriously and honestly employed in arranging parts to suit various positions or sites, and in attending to the minor wants of individual proprietors.

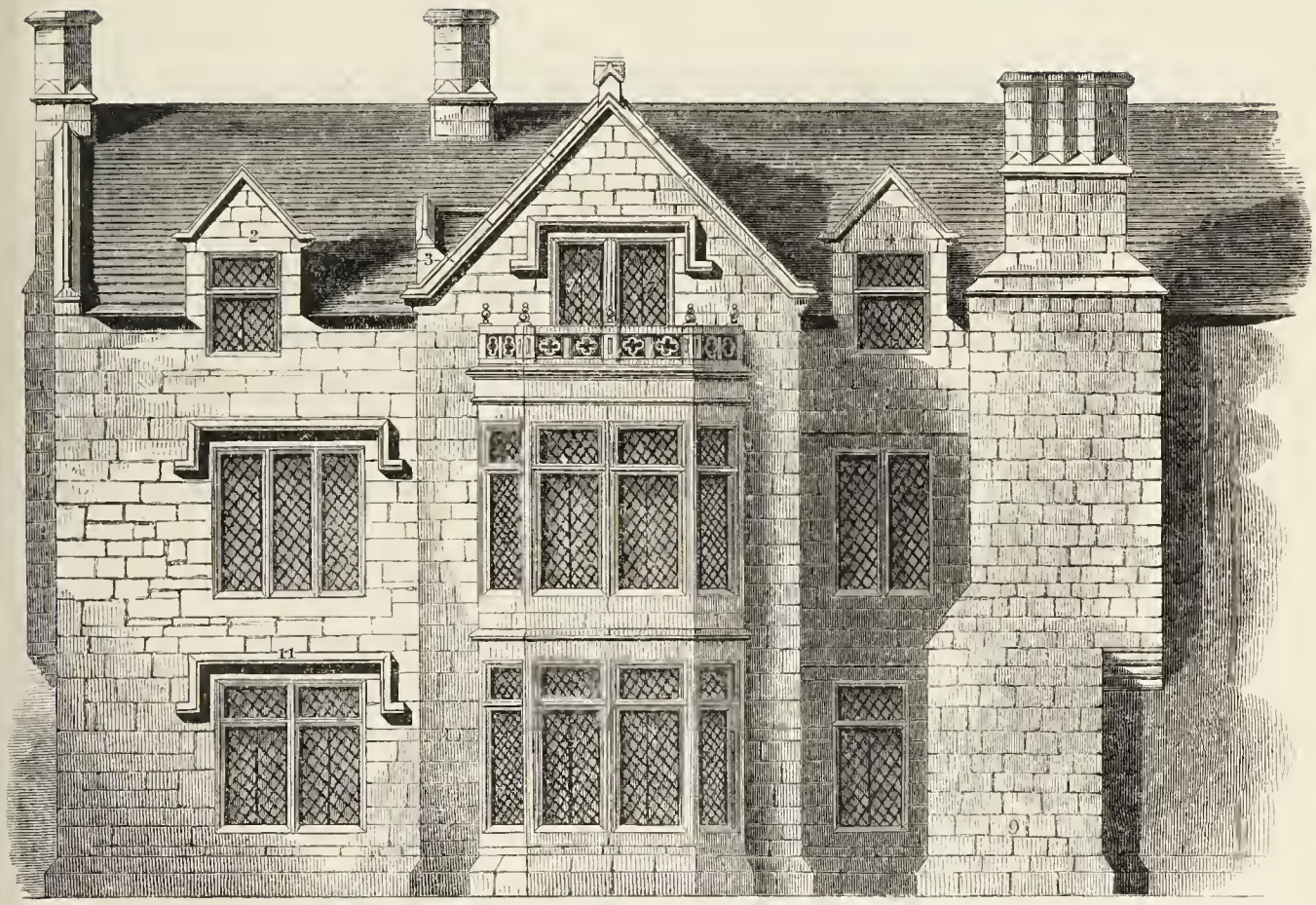
The Elizabethan style was no less the effect of useful considerations; for until debased by the ingrafting, so to speak, of Grecian and Italian features for purely decorative purposes, it was nothing more than useful house building, in forms suited to and suggested by the general and individual requirements of the period. Am I not justified in saying therefore, that the principle of usefulness, as carried out by the architects of former times, led to greater variety and grandeur than we, in consequence of our contempt for "what is convenient as a house," can yet boast of. Now, with reference to the commonly received opinion, that the final extinction of Architecture in this country was hastened by the commingling of Gothic, Grecian, and Italian features, I would observe, that had useful constructive purposes induced the using of these foreign features in one and the same building, I believe architectural science would not have suffered by any such union, for I maintain, that so long as columns, pediments, arches, corbels, or other forms, are usefully employed, the taste of the designer is not likely to deteriorate, but on the contrary, as his mind must be engaged in the work, his sense of fitness and feeling for beauty in form and arrangement will improve. This, as you are aware, is not the general opinion; at least the usual practice would lead to the belief, that in order to produce noble works of art, an architect has simply to become a copyist of Egyptian, Greek, or Gothic forms, for useless purposes. We find, that even on spinning mills or factories,

Grecian pediments are erected in positions where gables are not required, but merely that these may "break the line of roof." And when the more recently adopted form for a tall chimney is departed from, it does not appear to be from any consideration for greater fitness, but simply that the smoke may be seen ascending from the top of an Egyptian obelisk, instead of from a Roman column. Chimneys and chimney-tops seem to form a peculiar source of trouble to modern architects. For instance, instead of admitting the fact, that in many churches there are stoves, and constructing openly-avowed chimneys, they put themselves to no end of trouble, twisting vents that they may get the smoke out at the tops of buttresses, or at odd-shaped pinnacles, pretending to be any thing rather than chimney-tops. Now, since church walls are not built sufficiently thick to keep out the cold, and artificial heating resorted to, an architect might, I should think, endeavour to design an appropriately ornamented chimney, and give it an honest place, and in so doing be guilty of no unpardonable offence against correctness in architectural design. I do not mean that chimney-tops cannot be, or are not made sufficiently ornamental, in all conscience, on secular buildings. I saw two or three on a modern castle the other day, each having as many columns, arches, and niches about it, as might have sufficed for constructing a small Roman temple, but still there appeared no sense of fitness in the design. There was no evidence that statues were to be the future occupants of those niches. The columns neither had nor ever could have any constructive occupation, and therefore I cannot conceive why the mere placing of these copies of ancient useful forms round a chimney-top, for purely idle decoration, should have been considered proof of architectural talent. We should not, I presume, award great praise to

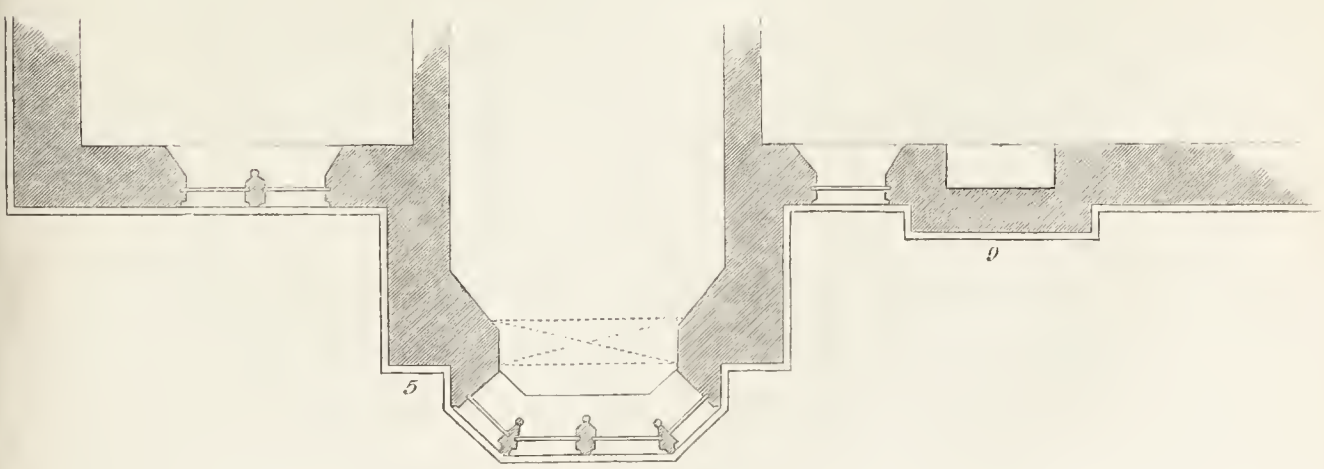
a painter, who when asked to paint a historical picture, merely copied individual figures from pictures found here and there amongst the works of the ancient masters, and placed those copies, regardless of the story, in attitudes to please the eye educated in pictorial composition. And yet, would not that painter be as much entitled to the merit of having made an original design, as an architect whose works consist of slavish copies of old features, arranged in classic order or in picturesque disorder, as the case may be, regardless of constructive necessity or useful purpose? Some time ago I visited a modern imitation of an ancient baronial castle, and on asking the person in charge of the building to allow me to examine the interior of one of its corner turrets, he replied — "I canna do that, for it's got nae inside." Now, although the building here referred to was constructed in accordance with plans and specifications furnished by an amateur, I am certainly not the less disposed to maintain, that a somewhat similar want of usefulness will be found to characterize the works of others than those who dabble in design for their amusement, and that were we to divest many buildings, enjoying great reputation at present, of all purely pretentious parts, we should leave those barely entitled to be considered representatives of the styles they assume. Imagine, for example, almost any modern Elizabethan edifice denuded of all its imitative gables, and small roofs and gables placed above windows lintelled or completed below the eaves or wall-level line, and therefore no more requiring separate roofs and gables than those placed in the basement storey — its unusable and unreachable balconies — its useless balustraded and battlemented parapets — its mock towers and turrets and other parts made merely to match, and its paltry imitations in stone of ancient wooden pendants and pinnacles, would it not then require an effort

A





B



on the part of the most willing writer of a puffing paragraph to say—"The building has been beautifully designed and carefully carried out in all its parts, in strict conformity with the Tudor style?"

By way of contrasting that absence of useful principle of which I complain, with the results of allowing usefulness to suggest and control the design, I have made those two drawings; and although, for reasons easily understood, I have avoided copying in its entirety any modern Elizabethan edifice, I am prepared to prove I have not exaggerated present deviations from ancient practice.

A represents half of a side or back elevation of a modern building; the other half, from the centre dotted line, c c, according to present ideas of "what is architecturally correct," would be an exact counterpart of that here shown. **B** represents a corresponding portion of a building, such as would have been constructed for like purposes at a time when architects did not consider it their bounden duty to make both halves of each elevation of a building or range of buildings precisely to match, regardless of interior requirement.

At figure 1 on both drawings chimneys are projected. The projection on A 1, commencing, as it does, at a point on the gable wall above the ceiling of the upper room in the house, could not be suggested by useful considerations. It is an abortive imitation of an ancient chimney shown at B 1, such as were required for the proper construction of the large open fireplaces common to the Elizabethan period, to the advantages arising out of which I may afterwards shortly allude. The projection being at a point a little below the ceiling of the ground floor, the necessity is supposed to arise in consequence of a fireplace being required for the room on the first floor. I have not made an eleva-

tion of the gable here shown in profile. Had I done so, and placed a window or a door under the chimney, I should have shown a common reason for such projected parts. Therefore, I may again mention, that by carefully examining old buildings, any person may satisfy himself of the truth of what I state: that exterior projections were not in former times made merely to gratify an idle desire for picturesque forms, but were invariably the result of useful considerations; in some instances appearing as after-thoughts, suggested by altered interior arrangements, &c. Figs. 2, 3, 4, Plate A, are unmistakeably useless imitations of dormer gables, such as are represented on Plate B, figs. 2, 3, 4, where the windows rise above the wall-level line, and consequently require the construction of roofs and gables. The difference in point of usefulness between the gables and bay windows on both plans, will be made more apparent by a reference to the ground plans. The gable fig. 5, Plate A, from its position, close to the main wall, could not, it is clear, be suggested by a desire for greater interior accommodation; whereas that on Plate B, fig. 5, is sufficiently in advance, as clearly to show, that useful consideration might lead to its construction. These slightly projected gables are common in modern times, form features in other styles besides the Elizabethan, and owe their existence, like other and smaller excrescences, to a supposed necessity for breaking the plain surface. Now I maintain, that when such breaks were formed on really old Elizabethan or Franco-Scottish edifices, these it will be found were made not merely to give variety of line, or to produce light and shade, but in consequence of additional thickness being deemed necessary for the walls of lofty towers, and other parts intended to be raised above the general height of the building. The oriel or bay windows are not so dissimilar, in

point of usefulness, as the other corresponding features—the difference between the modern and the ancient example appearing more in the mode of construction than in interior form. For instance, a wooden beam, in the modern example, is made to serve the purpose of supporting the upper portion of the gable; whereas in the old example, a stone arch is shown. There will be found, however, a very marked difference in the two balconies. The window, fig. 6, A, is merely a stone imitation, and as no other access to the balcony is provided, both it and the expensive parapet cannot be other than useless and paltry, although a common mocking of an ancient balcony, such as is shown at fig. 6, B; the window, fig. 7, B, being a reality, and made sufficiently large to allow of its useful occupation.

On gable A, fig. 8, I have shown the tracks of two vents, the fire-places being, as they frequently are, inside of spaces that appear as windows on the finished elevation. Now, were we to follow the practice of olden times when constructing chimneys, I venture to say, we should have fewer smoky grievances to complain of; but so long as we do not, and will consider six or seven inches of building sufficient between the external atmosphere and the vent, we are likely to be occasionally almost driven to our wit's end, devising and using patented contrivances for the curing of smoky chimneys. Our badly constructed and thin walls render it necessary, in order to get the vent "to draw well," that fire-places and grates should resemble furnaces in form, and these in effect cause the overheating of small and ordinary sized rooms, and make the proper ventilating of apartments one of the difficulties of the day. Whereas, were fire-places to be formed as in olden times, open about four feet or so above the floor, and proportionately wide, and additional thickness given to the walls on each side of the vent, either by their

being projected inside or outside, in the manner shown at figure 9, Plate B, we should probably stand less in need of registered stoves, or of modern scientific ventilation. The corbelling out on the one side, and the intake on the other, here represented, would be necessary to suit internal requirements; for unless by increasing the width of the projected part at the ground, and carrying it up all the height, suitable fire-places could not be constructed in the three apartments for which the chimney is intended.

These five windows, fig. 10, Plate A, and the one above the oriel window, are all stone, and of course cannot be otherwise than useless as windows. These string courses or drip mouldings, fig. 11, A, somewhat resemble old examples in form, but do not serve the same useful purpose. Ancient drip mouldings were placed over windows, doors, and other openings or recesses, in the manner shown on Plate B, fig. 11, and for the purpose, as the name implies, of carrying the drip over parts requiring protection from the weather, such as moulded and carved mullions, &c. Those shown at fig. 11, A, are placed, as in many modern buildings, merely to break the surface of the small space of plain wall between the upper and the lower windows. The ancient use or origin of the corner ornament, fig. 12, A, is almost lost sight of in the change of form. When houses came to be built with stone, and gable boards were no longer necessary for sheltering the ends of roof-beams, thatch, or shingles, gable walls were raised higher than the side walls at each end, so as to cover in the roof timbers and the material above, whether thatch or slates. The parts of the gable wall so raised were generally corbelled out a little beyond the surface of the wall underneath, and frequently ingeniously and appropriately ornamented. I may here take occasion to remark in passing, that this practice

of decorating the exposed terminations of upright walls is of very ancient origin; for instance the antæ—the prototype of the modern pilaster—was simply the finish given to the end of a useful wall; but these ancient antæ were not placed in any other position, neither had they mouldings the same as the columns used in the same building, or belonging to the same order as the modern imitation. But to return; ornamented gable ends or skew stones, were usually finished by the gable cope moulding, and occasionally contained armorial or other carved ornaments, but I have never seen an ancient example resembling the present absurd form, which appears to be the result of an idle attempt to combine the Elizabethan skew stone with the Franco-Scottish corner turret. Now, although I need scarcely say, that all these useless parts add vastly to the cost of modern buildings, I would ask, why do we rest satisfied with the idea that this practice of constructing mere idle imitations of ancient useful forms will lead us to greatness in Architecture? We do not consider conventionalism evidence of talent on the part of those who profess to be learned in other arts. In music, we hesitate not to prefer genuine feeling to the drawing-room thunderings of some semi-grand Maestro, of whose power our ears alone are sensible. We have ceased to consider conventional compositions of brown foregrounds and blue hills proofs of excellence in landscape painting; and we now hear less of style and noble rules from those who no longer feel their dignity offended, or their genius questioned, when told their works look like simple transcripts of nature. And why? Because landscape painters have got beyond that conventionally noble stage whereat we are still standing in Architecture, and where, I fear, we are doomed to remain, until such time as we can make up our minds to allow a little more scope to our common sense, when endeavouring

to determine between reality and pretension in constructive art. I say this much, believing that unless a work of art, no matter whether of architecture or painting, can bear the test of reason and common sense, no great amount of that quality of mind correctly denominated genius, can have been employed in its production. The young and enthusiastic artist may deem this a grovelling mode of ascertaining the extent of his powers. It may be so. Still I am disposed to maintain, notwithstanding, that were we to insist on having every part of our buildings made reasonably useful, we should be infinitely nearer arriving at the knowledge of what really and truly constitutes a work of architectural genius, and towards making the discovery, that ancient Gothic art owed its existence, not to a love for idle decoration, but to that feeling for constructive fitness and grandeur of form possessed by those who were indeed men of genius, ever actuated by simple honesty of purpose. Could we but follow their example even in truthfulness of material in individual forms or features, we should possibly come to consider the present practice of supporting heavy stone walls on rods of iron, enclosed and concealed by mock columns, composed of thin wooden boards and plaster capitals, scarcely consistent with the dignity of true constructive science. We admire *old stone* pillars: those in Roslyn Chapel, for example; and are not church restorers busily employed everywhere at present in taking plaster and paint from off old Gothic columns? Therefore, when thus showing our anxiety for the re-appearance of ancient forms in all their original honesty of material, why should we object to place a veritable stone pillar under a stone wall in a modern building, and to let it appear as such? I know it will be said in answer to this, Provided the required degree of strength is obtained by an "*iron core*," why object to its being encircled with wood, and

thereby made to assume a massive appearanee? Now I objeet for two reasons: If there is room for a massively got up column, there will be spaee for a suitable stone pillar; and by eonstructing the latter, we will show a greater regard for truth — a great desideratum in modern Architecture.

But lest my having eonfined these remarks hitherto to the eonsideration of usefulness as a eontrolling prineiple, should have led you to suppose I wish to deny that we derive pleasure from viewing columns, arehes, or other forms, either singly or in combination, altogether irrespeetive of constructive fitness, I beg to state, that so far from disputing this fact, I unhesitatingly assert, that but for our innate liking for pleasing forms, purely as such, we should not have so long remained satisfied with the shadow for the substance of construetive arehitecture; nor so long continued to aet as if arehitectural excellenee could only be attained by a servile repetition of the five orders. We admire the columnar form, for instance, whether in art or nature, whether in the tree of the forest or in the Gothie or the Greeian column; and when columns are arranged, as they usually are, on the exteriors of elassieal edifices, few, I should think, will feel disposed to deny, that a pleasing effect is produced. But this gives rise to other questions, Does the pleasure then and there experieneed, arise in our minds in consequence of each and all of those columns having been made coldly correct, aeording to the latest measurements; or from their having beeu plaeed just so far and no farther apart; or because there are just so many and no more on one or on both sides of the building? I cannot believe so. A sense of fitness for construetive purposes demands, certainly, that all the columns employed in supporting one and the same line of entablature should be of a uniform height, and for this very obvious reason, that an

uneven or broken entablature would produce an appearance of instability. This fitness, arising from a uniformity of height in that particular part, cannot, however, be the cause of our general admiration of the columnar form, otherwise we should not derive the pleasure we do when viewing either a lengthened avenue or the nave of a Gothic cathedral. And where columns are used, where no necessity is supposed to exist for sameness in height or girth in Gothic construction, the eye, so far from feeling offended, is gratified by the variety produced. Pursuing this question of beauty as arising out of exactness in form and measurements a little further, do we not derive as much pleasure when looking on a long line of Gothic pillars, having all their mouldings varied in size and form, as we do when viewing a Grecian colonnade or portico, where the slightest variation either in size or form of these minor parts is considered an unpardonable offence against correctness in taste? Therefore, why should the precise proportions of columns, entablatures, and other parts used originally in constructing Grecian temples (and no two authorities agree entirely as to these proportions), be considered an unalterable standard of excellence, any more than that accurate measurements taken from one or two Gothic churches, should be implicitly followed as unerring guides to architectural design? We have no greater reason for believing that Ictinus, Callicrates, or Phidias, formed the model for the Doric column of the Parthenon, according to measured proportions, than that the latter created his statue of the goddess Minerva, by obeying the arbitrary rules of a previously recognized standard of beauty. Measurements being only necessary for the workman and the plagiarist, we may, I think, safely conclude, that architects placed their faith in measured greatness only when invention ended.

I shall now very briefly point out a few deviations from ancient practice, observable in the interiors of modern buildings. Our lath and plaster panelled and groined ceilings are purely imitative and useless. Ponderous looking beams, through which we might poke our walking sticks could we but reach them, feign to support realities they merely hide. In the place of the ancient cornice, which served to aid in supporting joists and roof beams, we fasten up plaster hollows, rounds, and flats, all specially formed so as to contain as many as possible of stereotyped castings, technically called enrichments; and we appear to consider these plaster forms so many indications of our progress in appropriate decoration; whereas, so far from ornamental plaster work ever having been associated with true architectural progress, it came prominently into use only on the decline of truthful art. When surface decoration came to receive too much attention from the architect, and in consequence the supply of ornament did not keep pace with the demand, the worker in plaster was brought to aid the sculptor and the carver, just as he has again to suit the demand created by commercial art in our times, given place to the moulder, or castor of previously existing ornaments, whose talents we do not confine to moulded or panelled ceilings, but occasionally employ in imitating ancient wainscoting, thereby making it appear that we consider wood panelling to be the mere whim of the carpenter, instead of what it is, a constructive necessity on his part, for he can no more finish the interior of a room with one board than a mason can build a wall with one stone. Therefore, we may term panelling building in wood; and were architects, instead of designing plaster imitation panels, to encourage and instruct carpenters how to emulate their brethren of former times, they would undoubtedly be doing more towards the

advancement of genuine constructive Architecture. Another instance of idle copyism will be found in the form and use of those features called door-capes. In olden times, monograms, mottoes, and other appropriate devices, were carved and placed over doors immediately above the architrave. Now in imitation of, and in the place of those ancient friezes, our architects put up plain boards, which they surmount with Grecian and other cornices, for the purpose, as they say, of making the door-ways have a loftier appearance, and for the like reason they construct empty pediments. Now we should not, I presume, pay much attention to the advice of any architect who would advise us, in order to break the plainness of an interior wall, to hang thereon a number of empty picture frames, and yet what are all those empty pedimcnts we see on the interior, and on the exterior of classical and other buildings, but empty sculpture frames? When placed over doors and windows, as they usually are, on what are called Italian elevations, they serve no useful purpose whatever; not being intended for, they are not constructed so as to serve the place of drip mouldings. These empty pediments are idle features of an idle style, and nothing more; and I believe, had not the long continuance of the practice blinded us to the folly, we should scarcely feel disposed to carry it on now at so much cost.

Before concluding, allow me to express an earnest hope, that these remarks will be taken in good part. They have been made from an honest motive and with a good intention, in the belief that useful and ornamental Architecture cannot result from the eye and the hand alone, but must be the work of reason, acting along with an innate feeling for beautiful form. Our sense of fitness must be satisfied when the mind is employed in designing for useful purposes; not so, however, when engaged in the practice of imitative

Architecture. No constructive fitness comes to disturb the even tenor of the plagiarist's thoughts. He goes on comfortably, copying, arranging, and re-arranging; now and then, it may be, inquiring if there is any likelihood of a new style arising, and conjecturing, whether it will come out of the materials of iron and glass, or be produced by a new arrangement or combination of the leading features of former styles, and so stand forth a purely decorative conglomerate, formed by the uniting of all previously existing remains.

In conclusion, I beg to repeat my belief, that could we only bring ourselves to follow ancient example, allow our requirements to suggest the form of our buildings, or in other words, give greater consideration to "what is convenient as a house," we should sooner arrive at being really "correct in architectural design," and out of this regard for truthful form, re-create the only true style.

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Session 1855-56.

No. IV.

ON

WROUGHT AND CAST IRON BEAMS.

BY

THOMAS DAVIES, Esq. F.A.I.S.

[*Read at a Meeting of the Institute in Edinburgh, held on* 18*th February* 1856.]

I. Wrought Iron Beams.

The material first used in the construction of Beams was doubtless timber, and although it has many properties peculiarly fitting it for this purpose, yet, on account of its flexibility, and the difficulty of getting it of sufficient size and strength for long spans, its tendency to decay, and its destructibility by fire, it is in many cases unsuited for the purpose required.

When the manufacture of cast metal became more general, and the means were obtained of making large castings, the applicability of this material to the formation of beams could not fail to suggest itself. This material has decided advantages — in its rigidity, in its capability of being made of almost any required shape and strength, in its non-liability to decay, and in its incombustibility; and consequently, it has come to be very extensively used for the purpose referred to.

There has, however, been a general want of confidence in Beams of this material, arising from different causes. One objection is, that when a beam gives way, it does so without any previous warning. Another objection is, that although we have innumerable experiments on the strength of cast-metal, by which we are enabled to calculate the amount which any particular Beam of this material ought to carry, it does not follow that it will bear that

amount. In a large casting there may be some inequality in the metal used; again, if there is much difference in the thickness of the parts, the cooling of one part before another produces, to some extent, a tendency to fracture, especially if subjected to any sharp concussion; or the casting may be clean and apparently sound, and yet there may be a flaw, of which nothing can be known until it is revealed by a fracture. No doubt, to guard against these defects, we have the system of testing; but this is not always to be depended upon, as it has been considered, that in some cases Beams have been tested so nearly to the limits of their strength, that, though passing the ordeal, they have been permanently injured thereby. This suggests another objection, that though a Beam be in every way sound, yet, if it is occasionally subjected to great strains, it will ultimately be so much weakened, as to break with a load much less than the original breaking weight.

The result of the want of confidence above mentioned has been, that cast-metal beams are generally made much stronger, than, judging from experiment, they require to be, necessitating heavy castings and increase of cost, with the additional drawback of great weight and difficulty of handling.

Malleable iron Beams unite, to some extent, the advantages of both timber and cast-metal. They possess the advantage of timber, inasmuch as they are comparatively light, and therefore easily handled, and when overloaded, they show this by yielding considerably before breaking. They possess the advantage of cast-metal in their incombustibility, in their being capable of being conveniently made of any required strength, and even to some considerable extent, in their rigidity; for although malleable iron is comparatively flexible, yet this quality is in a great measure counteracted by the mode of constructing the Beams.

Messrs. Stephenson and Fairbairn, in their investigations and experiments relative to tubular bridges, were the first to call general attention to the use of malleable iron in the construction of Beams. After many experiments on various sections of tubes, they arrived at the rectangular tube, or Box Beam, as the best; and it was a simple step, by dividing it in two by a vertical line, to come to the double flange or Plate Beam, which is the most convenient shape for general use.

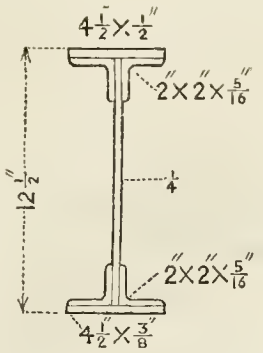
Mr. Fairbairn, in his valuable book on cast and wrought iron, shows the superiority, in many respects, of malleable over cast-iron

for Beams. He shows, moreover, that, contrary to what takes place in cast-metal, the upper flange requires to be larger than the under one, in the proportion of 2 : 1, and gives formulæ for calculating the strength of Beams. There is, however, this drawback, that while his book contains the details of many experiments on various sections of cast-metal and malleable-iron Box Beams, there is almost a complete want of experiments on malleable-iron Plate Beams. There is given, in fact, the result of only one experiment on one kind of Plate Beam, and this experiment was not altogether satisfactory.

This circumstance, there is little doubt, has tended to deter many from adopting this kind of Beam. Having made several experiments on the kind of Beam referred to, I considered, under the circumstances, that the results of some of these might be acceptable to this Institute, and might tend to the more general use of a Beam which has decided advantages for many purposes.

Having had my attention drawn to the applicability of malleable iron for Beams, and having long shared in the general want of confidence in cast-metal already alluded to, I determined to take the first opportunity of making a trial of them. An opportunity having afforded itself of using them, I consulted Mr. Tod, engineer, Leith Walk, and had the benefit of his experience; and I was so satisfied with the result of the trial, that since then I have not used cast metal for Beams of any importance. Mr. Tod has since then made many such Beams for other parties, so that they have to some extent become known and used in this locality, but still not so generally as, in my opinion, they deserve.

The Beams in my first experiments, I am sorry to say, were tested by a Bramah Press, which I afterwards discovered to be very inaccurate. The results of the experiments, however, which are to be laid before this meeting, are only those which have been obtained by the application of *dead weight*, so that there may be nothing to create want of confidence in the statements now laid before you. These experiments were made at various times, in Mr. Tod's yard. None of the Beams were tested till they broke, as all were intended for use; but, as most of them were tested to a deflection greater than that to which it would be advisable to have them permanently loaded, they give data for guidance in fixing the dimensions of other Beams.



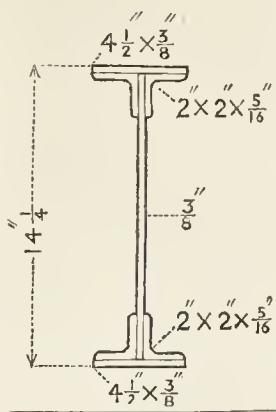
EXPERIMENT I.

LENGTH of BEAM ... ... 12 ft. 0 in.
„ BEARING ... 11 „ 8 „
WEIGHT of BEAM ... ... 4 cwt. 1 qr.

The load rested on 20 inches in the middle of the Beam.

Divisions of Load.			Load.			Deflection Loading.		Deflection Unloading.	
Cwts.	Qrs.	lbs.	Cwts.	Qrs.	lbs.	Ins.	16ths.	Ins.	16ths.
0	0	0	0	0	0	0	0	0	0
33	0	21	33	0	21	0	2	0	3
42	2	14	75	3	7	0	3	0	4
65	2	14	141	1	21	0	4	0	5 nearly
38	3	0	180	0	21	0	5		
27	0	7	207	1	0	0	6	0	6 full
28	3	20	236	0	20	0	7	0	7

LOAD ... ... $11\frac{3}{4}$ tons.
DEFLECTION ... ... $\frac{7}{16}$th inch.
There being no apparent PERMANENT DEFLECTION.



EXPERIMENT II.

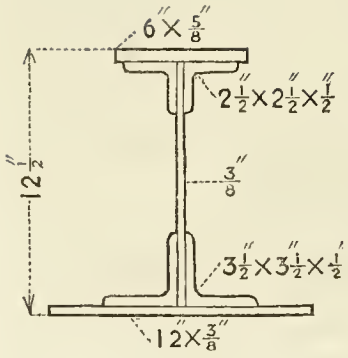
LENGTH of BEAM ... ... 17 ft. 2 in.
„ BEARING ... 16 „ 6 „
WEIGHT of BEAM ... ... 6 cwt. 2 qrs.

The load rested on 21 inches in the middle of the Beam.

Divisions of Load.			Load.			Deflection Loading.		Deflection Unloading.	
Cwts.	Qrs.	lbs.	Cwts.	Qrs.	lbs.	Ins.	8ths.	Ins.	8ths.
0	0	0	0	0	0	0	0	0	1
37	2	0	37	2	0	0	1	0	2
33	0	24	70	2	24	0	2	0	3 nearly
54	2	16	125	1	12	0	3	0	3 full
52	0	0	177	1	12	0	4	0	4 full
52	0	0	229	1	12	0	5	0	5

LOAD ... ... $11\frac{1}{2}$ tons.
DEFLECTION ... ... $\frac{5}{8}$ths inch.
PERMANENT DEFLECTION ... ... $\frac{1}{8}$th inch.

EXPERIMENT III.



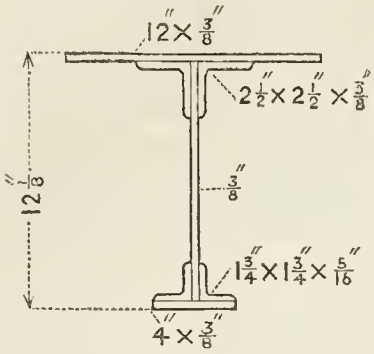
LENGTH of BEAM ... 30 ft. 0 in.
„ BEARING... 28 „ 6 „
WEIGHT of BEAM ... 20 cwt. 2 qrs.

The load rested on 27 inches in the middle of the Beam.

Divisions of Load.			Load.			Deflection Loading.		Deflection Unloading.		
Cwts.	Qrs.	lbs.	Cwts.	Qrs.	lbs.	Ins.	8ths.	Ins.	8ths.	
0	0	0	0	0	0	0	0	0	3	
34	1	4	34	1	4	0	2	0	5	
12	3	12	47	0	16	0	3	0	6	
9	2	16	56	3	4	0	4	0	7	nearly
13	3	20	70	2	24	0	5	1	0	nearly
12	3	12	83	2	8	0	6	1	0	full
16	0	8	99	2	16	0	7	1	1	full
13	0	0	112	2	16	1	0	1	2	
13	0	0	125	2	16	1	1	1	3	
13	0	0	138	2	16	1	2	1	4	nearly
13	0	0	151	2	16	1	3	1	4	full
13	0	0	164	2	16	1	4	1	5	
13	0	0	177	2	16	1	5	1	6	
13	0	0	190	2	16	1	6	1	7	
13	0	0	203	2	16	1	7			
13	0	0	216	2	16	2	0	2	0	

LOAD ... ... $10\frac{3}{4}$ tons.
DEFLECTION ... ... 2 inches.
PERMANENT DEFLECTION ... ... $\frac{5}{8}$ inch.

EXPERIMENT IV.



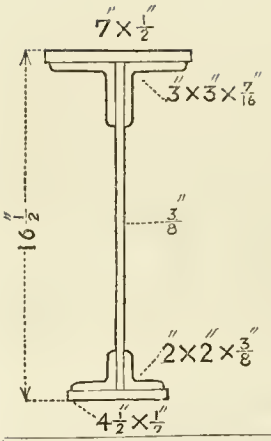
LENGTH of BEAM ... 29 ft. 6 in.
„ BEARING 28 „ 6 „
WEIGHT of BEAM ... 14 cwt. 3 qrs.

The load rested on 22 inches in the middle of the Beam.

LOADING.			UNLOADING.		
Divisions of Load.	Load.	Deflection.	Divisions of Load.	Load.	Deflection.
Cwts. Qrs. lbs.	Cwts. Qrs. lbs.	Ins. 8ths.*	Cwts. Qrs. lbs.	Cwts. Qrs. lbs.	Ins. 8ths.*
0 0 0	0 0 0	0 0	0 0 0	0 0 0	0 3½
„ „ „	„ „ „	„ „	5 3 8	5 3 8	0 4
17 1 24	17 1 24	0 1	8 2 26	14 2 6	0 5
11 2 16	29 0 12	0 2	11 2 16	26 0 22	0 6
11 2 16	40 3 0	0 3	11 2 16	37 3 10	0 7
11 2 16	52 1 16	0 4	11 2 16	49 1 26	1 0
8 2 26	61 0 14	0 5 nearly	11 2 16	61 0 14	1 1
11 2 16	72 3 2	0 6	11 2 16	72 3 2	1 2
11 2 16	84 1 8	0 7 full	11 2 16	84 1 18	1 3
8 2 26	93 0 16	1 0	11 2 16	96 0 6	1 4
8 2 26	101 3 14	1 1	11 2 16	107 2 22	1 5
11 2 16	113 2 2	1 2 full			
8 2 26	122 1 0	1 3	11 2 16	119 1 10	1 6
8 2 26	130 3 26	1 4	11 2 16	130 3 26	1 7
8 3 22	139 3 20	1 5	15 0 22	146 0 20	2 0
9 1 14	149 1 6	1 6 full			
6 1 0	155 2 6	1 7	12 2 0	158 2 20	2 1
6 1 0	161 3 6	2 0			
6 1 0	168 0 6	2 1 full			
3 0 14	171 0 20	2 2	12 2 0	171 0 20	2 2

LOAD ... ... $8\frac{1}{2}$ tons.
DEFLECTION ... ... $2\frac{1}{4}$ inches.
PERMANENT DEFLECTION ... ... $\frac{7}{16}$ inch.

* The deflections were observed to 16ths of an inch, but the 8ths only are here given.



EXPERIMENT V.

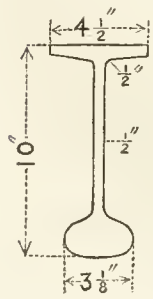
LENGTH of BEAM ... ... 23 ft. 6 in.
„ BEARING ... 22 „ 6 „
WEIGHT of BEAM ... ... 13 ewt. 2½ qrs.

The load rested on 21 inches in the middle of the Beam.

LOADING.				UNLOADING.			
Divisions of Load.	Load.	Deflection.		Divisions of Load.	Load.	Deflection.	
Cwts. Qrs. lbs.	Cwts. Qrs. lbs.	Ins.	16ths.	Cwts. Qrs. lbs.	Cwts. Qrs lbs.	Ins.	16ths.
0 0 0	0 0 0	0	0	0 0 0	0 0 0	0	2
„ „ „	„ „ „	„	„	17 1 24	17 1 24	0	3
34 3 20	34 3 20	0	1	20 1 14	37 3 10	0	4
20 1 14	55 1 6	0	2	23 1 4	61 0 14	0	5
26 0 22	81 2 0	0	3	23 1 4	84 1 18	0	6
23 1 4	104 3 4	0	4	23 1 4	107 2 22	0	7
20 1 14	125 0 18	0	5	23 1 4	130 3 26	0	8
18 1 8	143 1 26	0	6	25 0 0	155 3 26	0	9
18 3 0	162 0 26	0	7				
18 3 0	180 3 26	0	8	25 0 0	180 3 26	0	10
18 3 0	199 2 26	0	9	25 0 0	205 3 26	0	11
15 2 14	215 1 12	0	10				
15 2 14	230 3 26	0	11	25 0 0	230 3 26	0	12
12 2 0	243 1 26	0	12	21 3 14	252 3 12	0	13
12 2 0	255 3 26	0	13				
13 1 12	269 1 10	0	14	16 1 26	269 1 10	0	14

LOAD ... ... 13½ tons.
DEFLECTION ... ... ⅞ths inch.
PERMANENT DEFLECTION ... ... ⅛th inch.

I have as yet had only one opportunity of testing a rolled malleable iron Beam, of which the following is the result —



EXPERIMENT VI.

LENGTH of BEAM ... ... 10 ft. 9 inches.
„ BEARING ... 10 „ 3 „
WEIGHT of BEAM ... ... 3 ewt. 0 qrs. 21 lb.

The load rested on 8 inches in the middle of the Beam.

On account of some circumstances, the testing was not quite so satisfactory as could have been desired, so that the observed intermediate deflections are not given. The TOTAL LOAD, however, was (204½ cwt. =) 10¼ tons. The DEFLECTION was ⅜ths of an inch, or perhaps $\frac{7}{16}$ths of an inch. The PERMANENT DEFLECTION, after the removal of the load, was ⅛th of an inch.

It ought to be noticed, that the loads by which the beams in the foregoing experiments were tested, consisted for the most part of railway bars, requiring two men at each end to lift them, and that in loading there was a considerable amount of concussion and vibration, so that the test was considerably more severe than that due to the mere application of the load stated.

The foregoing are the details of all the experiments I have to bring before the meeting. I do not attempt from so few cases to generalize; but in the meantime I leave them before the Institute for their consideration. I may mention, that I am inclined to doubt the accuracy of the proportions of the upper and under flange for Plate Beams, as given by Mr. Fairbairn; but I am not at present in a position to speak definitely on this subject.*

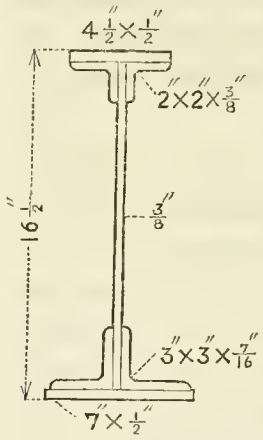
There is one remark, however, which I beg to make, before concluding this part of the paper. The elasticity of malleable-iron Beams is no doubt greater than that of cast-metal Beams, but it is not so great as to prevent them being used for most purposes. For instance, it might be supposed that such Beams were, from this cause, inapplicable to the support of walls already built, where the lower part has to be removed, as in the case of the alterations in shop fronts, which are continually being made in this city; but I may give the result of an experiment made in an alteration in Princes Street, as a case in point.

A pair of Beams were used, similar to that referred to in Experiment II. except that they were 2 inches deeper, the length being 14 inches greater, and the actual bearing, when put in their place, being 16 feet 8 inches. After the masonry above the Beams had been keyed up, and the supports to the walls removed, so as to throw the whole weight of the wall above upon them, the deflection was only $\frac{1}{20}$th of an inch. I do not mean to say, that this was all the Beams had yielded; but the keying up, before the supports were removed, had taken up whatever additional yielding there had been, although this must have been very little, as there was no appearance, so far as the eye could detect, of any deflection in the Beams.

* See Note A, at the end of this section.

NOTE A.

As already stated in the body of the paper, I was inclined to doubt the accuracy of the proportions of the upper and under flanges, as stated by Mr. Fairbairn. Since then I have made another experiment upon the Beam used in Experiment, No. V. but reversed; that is, with the large flange undermost, the results of which are given in the annexed table —



EXPERIMENT VII.

(Same Beam as tested in Experiment V. the larger flange being undermost.)

LENGTH of BEAM ... 23 ft. 6 inches.
„ BEARING ... 22 „ 6 „
WEIGHT of BEAM ... 13 ewt. 2½ qrs.

The load rested on 21 inches in the middle of the Beam.

LOADING.			UNLOADING.		
Divisions of Load.	Load.	Deflection.	Divisions of Load.	Load.	Deflection.
Cwts. Qrs. lbs.	Cwts. Qrs. lbs.	Ins. 16ths.	Cwts. Qrs. lbs.	Cwts. Qrs. lbs.	Ins. 16ths.
0 0 0	0 0 0	0 0	0 0 0	0 0 0	0 3
24 2 1	24 2 1	0 1	19 0 7	19 0 7	0 4
17 1 3	41 3 4	0 2	19 2 21	38 3 0	0 5
18 0 24	60 0 0	0 3	21 1 0	60 0 0	0 6
18 0 24	78 0 24	0 4	27 1 8	87 1 8	0 7
14 3 16	93 0 12	0 5 nearly			
17 1 12	110 1 24	0 6	34 2 24	122 0 4	0 8
20 1 0	130 2 24	0 7			
20 1 0	150 3 24	0 8	34 2 24	156 3 0	0 9
23 0 16	174 0 12	0 9	31 3 8	188 2 8	0 10
20 1 1	194 1 13	0 10			
17 1 18	211 3 3	0 11	23 0 23	211 3 3	0 11
15 0 20	226 3 23	0 12	15 0 20	226 3 23	0 12
15 0 20	242 0 15	0 13	15 0 20	242 0 15	0 13
15 3 6	257 3 21	0 14	15 3 6	257 3 21	0 14
12 0 16	270 0 9	0 15	12 0 16	270 0 9	0 15

LOAD ... ... 13½ tons.
DEFLECTION ... ... 1 5/16ths inch.
PERMANENT DEFLECTION ... ... 3/16ths inch.

The circumstance of this being the same Beam which was tested in Experiment V. and which received a set of $\frac{1}{8}$th of an inch in the opposite direction from that in which it was strained in the present instance, accounts for the apparent anomalies in the above experiment, as compared with the results of the former. Thus, at the commencement of the second testing, the Beam falls more quickly than on the former occasion, while as the experiment proceeds, it seems to recover strength, and there is little difference in the ultimate strength in both cases. Again, in unloading, the Beam in the second testing springs up more quickly than in the first, which is inconsistent with the idea of its being weaker, as the observed deflections imply.

An allowance ought therefore to be made for the previous set of $\frac{1}{8}$th of an inch, and the following table is probably near what ought to be substituted for that just given.

EXPERIMENT VII. (as corrected.)

Loading.			Unloading.		
Divisions of Load.	Load.	Deflection.	Divisions of Load.	Load.	Deflection.
Cwts. Qrs. lbs.	Cwts. Qrs. lbs.	Ins. 16ths.	Cwts. Qrs. lbs.	Cwts. Qrs. lbs.	Ins. 16ths.
0 0 0	0 0 0	0 0	0 0 0	0 0 0	0 1
" " "	" " "	" "	19 0 7	19 0 7	0 2
35 0 0	35 0 0	0 1	19 2 21	38 3 0	0 3
23 0 0	58 0 0	0 2	21 1 0	60 0 0	0 4
27 0 0	85 0 0	0 3	27 1 8	87 1 8	0 5
25 1 24	110 1 24	0 4	34 2 24	122 0 4	0 6
20 1 0	130 2 24	0 5			
20 1 0	150 3 24	0 6	34 2 24	156 3 0	0 7
23 0 16	174 0 12	0 7	31 3 8	188 2 8	0 8
20 1 1	194 1 13	0 8			
17 1 18	211 3 3	0 9	23 0 23	211 3 3	0 9
15 0 20	226 3 23	0 10	15 0 20	226 3 23	0 10
15 0 20	242 0 15	0 11	15 0 20	242 0 15	0 11
15 3 6	257 3 21	0 12	15 3 6	257 3 21	0 12
12 0 16	270 0 9	0 13	12 0 16	270 0 9	0 13

Load ... ... $13\frac{1}{2}$ tons.

Deflection ... ... $\frac{15}{16}$ths inch.

Permanent deflection ... ... $\frac{1}{16}$th inch.

It would have been desirable, in order to have obtained the strength of the Beam, as above, without requiring to have recourse to allowances, to have used a Beam which had not been previously strained by testing. This was intended in making the above experiment; but through a mistake, the same Beam was used over again, and there was not an opportunity of making another experiment before the Beams were sent away.

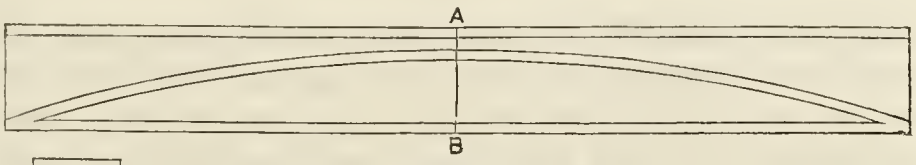
It would be very unadvisable to attempt to draw particular conclusions as to the exact proportions of the upper and under flanges, from these two experiments merely, but the results seem to warrant us in coming to the general conclusion, that for this kind of Beam THE FLANGES OUGHT TO BE NEARLY EQUAL, the under flange being rather larger than the upper.

Since making this last experiment, and coming to the above general conclusion, and while preparing this paper for the press, I have seen a new work by Mr. Fairbairn, entitled, "Useful Information for Engineers." In it he inserts some of the mathematical investigations of Mr. Tate on the subject, which quite agree with the statements here made. Mr. Tate concludes his remarks by saying — "The difference in the value of these constants is so small, as to lead us to infer, that the Beam in Experiment 12 approaches to that of maximum strength with a given quantity of material. The sectional area of the top and bottom flanges are to each other as 14 : 15, which is very nearly a ratio of equality."

II. Cast Iron Beams.

Whatever be the recommendations of wrought iron for Beams, there will always remain many cases in which it will be expedient to use cast-metal for the same purpose. It is desirable, therefore, that when the latter is adopted, it should be used with an appreciation of its properties, and of the proportions required for the different parts of the Beam, so as to attain a given strength with the least amount of material.

I do not think there is sufficient attention paid to this, at least in this locality, if we may judge from the sections of the Beams used in this city, in so far as they have come under my observation: For instance, I may refer to a description of Beam which I have noticed several times, and of which the annexed is a sketch —



Elevation.

Section on line A. B.

In this case the arched rib is quite useless, occupying the worst position in which the metal composing it could be placed. At the middle of the Beam it occupies as nearly as possible the position of the neutral axis, where there is neither a force of compression nor one of extension acting, and where, consequently, the metal is completely thrown away. Were the Beam cast plain, it would be quite as strong, and would be more easily modelled and moulded, and the casting would more likely be better; whereas, if the metal of the arched rib were thrown into the lower flange, the Beam would be very considerably strengthened.

But leaving this particular instance, I think there is generally very little attempt made to approximate to the strongest section of Beam. There are no doubt many particular cases in which this cannot be followed out, as, for instance, where it is required to have the upper flange broad for the purpose of receiving its load; but still I think, that even in such cases the strongest section might more nearly be approximated to than seems usual.

I do not attribute this to a want of knowledge of what is written on the subject, so much as to a want of confidence in what is written. I believe there is a feeling, that although a certain section may be the strongest for Beams carefully cast, carefully handled, and carefully loaded, yet it is doubtful how far it may be the strongest, or at all events, the best for ordinary practical purposes. This feeling, however, may be carried too far, and though we do not go to the extreme of what is shown to be the strongest section by experiment, we ought to approximate to it much more closely than we do, and as far as other considerations will allow.

That which is required to give the strongest section may be stated in a general way to be — to throw as much of the material as possible out of the web into the flanges, and — to make the lower flange considerably larger than the upper.

Mr. Hodgkinson, in a paper in the Memoirs of the Manchester Philosophical, gives as the result of his experiments, that the under flange should be to the upper in the proportion of 6 : 1. His

experiments having been extensive and carefully made, have ever since been considered the standard of reference, and I do not suppose that his conclusion on this subject has ever been called in question. However, having been led to examine his experiments for the purpose of condensing the results into a general law, or into a few statements that might be carried on the memory, I began to suspect that there was something wrong in the conclusion he had come to. At first I could scarcely bring myself to think, that this could be the case, after Mr. Hodgkinson's paper had been so long before the public, and after a considerable portion of it had been incorporated into two of the best works we have on this subject — "Barlow on the Strength of Materials," and "Fairbairn on Cast and Wrought Iron," by the authors of which, the opinions contained in it have thereby been homologated. I have looked, however, over the subject again and again, to see if by any possibility there might be lurking a fallacy in my reasoning, but I can see none. The conclusion then, on this particular point to which I have come, drawn from Mr. Hodgkinson's own experiments is, that the strongest section of Beam is that with flanges from $3\frac{1}{2}:1$ to $4:1$, instead of $6:1$, as stated by Mr. Hodgkinson.

The object of the remainder of this paper, is to lay my investigations on the question of the strongest section of Beam before the Institute, so as to enable it to judge of their correctness.

Before entering on the subject more particularly, I may indicate the nature of the oversight which I consider has been made by Mr. Hodgkinson. He gives the result of nine experiments on Beams, with double flanges of different proportions, from which he comes to the conclusion already stated. In comparing things together, as for instance in the present case, the comparison of the amount of strength due to the different proportions of upper and under flanges, it is necessary to have all other things equal, or that allowance be made for any difference, and Mr. Hodgkinson has accordingly had these Beams made of equal length and depth. He has, however, in his comparison left out of consideration the difference in the thickness of the webs.

Let us take an instance. The Beam No. 19 of Mr. Hodgkinson's experiments,* with flanges $6:1$, the proportion considered by him

* Continual reference requiring to be made to Mr. Hodgkinson's experiments, as recorded in the first part of Mr. Fairbairn's work on Cast and Wrought Iron, it will be necessary to refer to this work as being before us, as it would greatly and unnecessarily enlarge this paper, to incorporate with it all the experiments to be referred to.

the best, has a web containing only one-fifth of the sectional area, the other four-fifths being contained in the flanges which contribute by far the greater amount of strength to the Beam, so much so, that Mr. Hodgkinson throws the web out of calculation altogether. The Beam No. 3, with flanges 4 : 1 has, however, a web containing one-half of the sectional area, so that there is only the remaining half of the material contained in the flanges.

To compare the strength due to the different proportions of flanges in these two Beams, an allowance ought to be made for this difference. Let us take the material out of the web of the latter Beam, so as to reduce it to the same proportion as that of the former; namely, one-fifth of the sectional area, and let us put this surplus, amounting to 0·3 of the sectional area, into the flanges, where it may contribute its full value to the strength of the Beam. The area of the flanges, as already stated, is 0·5 of the sectional area; if then, we add 0·3 to this, we increase the strength of the Beam by three-fifths (that is, leaving out of consideration, in the meantime, the strength due to the web, which Mr. Hodgkinson neglects), so that this Beam, which broke with a weight of 2737 lbs. per square inch of section, would, by this alteration, have its breaking weight increased by three-fifths of this amount, namely ($2737 \times \frac{3}{5} =$) 1642 lbs., making in all the breaking weight per square inch of section 4379 lbs., while the Beam with flanges 6 : 1, broke with a weight of only 4075 lbs. per square inch of section. But this is not all: the metal of which the latter beam was cast, was stronger than that used for the former, as shown by the standard Beam cast along with them for comparison. By supposing the former Beam to be cast of the stronger metal, we will have to allow a further addition to its strength of about 510 lbs., so that the comparison will now stand thus —

	Breaking Weight per sq. in. of Section.
Beam with flanges 6 : 1	4075 lbs.
Do. do. 4 : 1	4889 ,,

giving an excess of strength in favour of the beam with flanges, 4 : 1, of about one-sixth.

But to enter on the subject more particularly and in detail —

Table I. shows the result of Mr. Hodgkinson's experiments, referred to in this paper.

TABLE I.

No. of Experiment.	Proportion of Flanges.	Strength per Square Inch of Section.		No. of Experiment.	Standard Beam. Strength per Square Inch of Section.
1	1 : 1	2368 lbs.			
2	2 : 1	2567 ,,	compared with	4	2584 lbs.
3	4 : 1	2737 ,,			
9	$4\frac{1}{2}$: 1	3183 ,,	do.	10	2792 ,,
11	$4\frac{1}{2}$: 1	3214 ,,	do.	13	2693 ,,
12	6 : 1	3346 ,,			
19	6 : 1	4075 ,,			
20	$6\frac{3}{4}$: 1	3576 ,,	do.	22	2885 ,,
21	$6\frac{3}{4}$: 1	3883 ,,			

Average of Standard Beam ... ... 2738 lbs.

The third column shows the actual load per square ineh of section with which the different Beams broke. As these Beams were not all cast at the same time, and as it was impossible to secure, at different castings, metal of exaetly the same quality, there was, at each set of experiments, a Beam of the same pattern, east for the purpose of aseertaining the comparative strength of the metal used in each casting, in order to allow of a comparison between the experiments made at different times. The result of these experiments on the standard Beam are given in the last column.

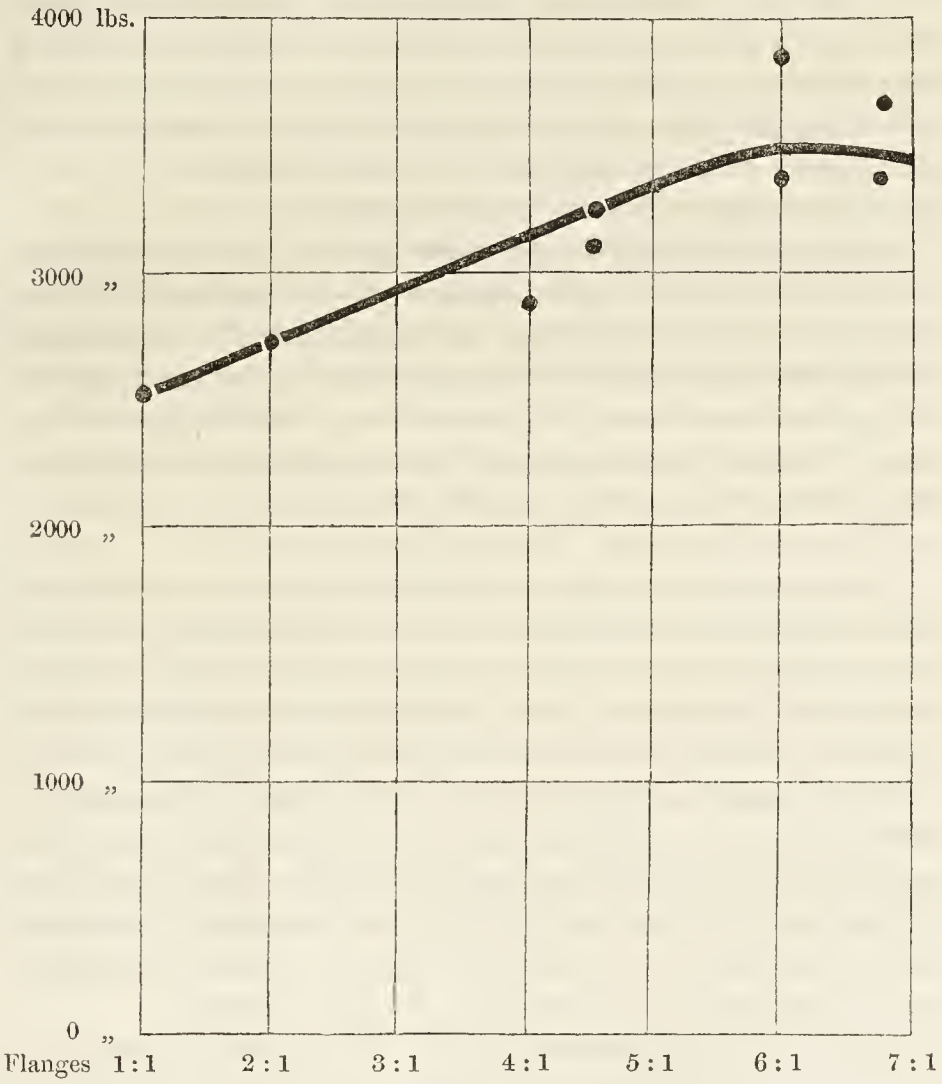
In order to compare the strength of the various Beams, we must reduce them to one standard. Let us take this standard to be the average strength of the standard Beam, which is 2738 lbs. per square inch of section ; then, by a simple question of proportion, we get Table II. instead of the former.

TABLE II.

No. of Experiment.	Proportion of Flanges.	Strength per Square Inch reduced to one Standard.
1	1 : 1	2509 lbs.
2	2 : 1	2720 ,,
3	4 : 1	2900 ,,
9	$4\frac{1}{2}$: 1	3121 ,,
11	$4\frac{1}{2}$: 1	3268 ,,
12	6 : 1	3402 ,,
19	6 : 1	3867 ,,
20	$6\frac{3}{4}$: 1	3394 ,,
21	$6\frac{3}{4}$: 1	3685 ,,

Diagram I. represents the same at one glance, the Beams, with flanges of different proportions, being marked off horizontally along the base or datum line, according to these proportions, and the various strengths of these Beams being measured by the height of the black dots above this base or datum line. The curved line represents, as nearly as possible, the law of variation of strength for Beams of different proportions of flanges, according to the above experiments.

DIAGRAM I.



The preceding Table and Diagram just referred to, show, that of the Beams experimented on, those with flanges about 6 : 1 were the strongest. But, as already stated, there ought to be an allowance made for the difference in the thickness of the webs of the

Beams experimented on, before we can compare the strength due to the different proportions of flanges.

There is some difficulty in making the calculations required for our purpose with exactness, on account of our want of knowledge of the exact proportions of the moduli of elasticity for compression and for extension of cast-metal, and whether these are constant or vary in some way, as the pressure — of the amounts to which this material may be extended or compressed, without injury to it — and thus of the position of the neutral axis for different sections of Beams.

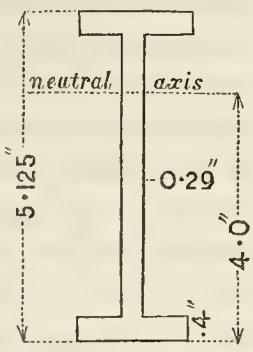
Were we to throw out of calculation the strength due to the web, we would be enabled to dispense with the consideration of the position of the neutral axis, &c., and the calculations required would be greatly simplified; while the difference, though comparatively small, would be still more in favour of Beams with the upper and under flanges of more equal proportions.

Although unable to fix the exact positions of the neutral axis for the various Beams, I have assumed probable positions according to the best of my judgment, considering that the assumptions, though perhaps not quite correct, will make a closer approximation to accuracy than leaving the question altogether out of consideration. I think, from calculations made on different assumptions of the position of the neutral axis, that any error that can arise from this cause will probably be under 3 per cent.

It may be noticed, in corroboration to some extent of the proximate correctness of the law assumed in regulating the position of the neutral axis in the different Beams, that the assumed positions agree very closely with those indicated by the fractures of the Beams in three of the four cases in which that position seemed to be thus indicated, although the law was assumed independently of these observations. Thus, in Beam No. 11, the assumed position is within 0·1 in. of the indicated position, while in Beams No. 19 and 21, the curve of the assumed law follows almost exactly the average between the indicated positions; in the former being 0·4 in. above, and in the latter 0·3 below these indicated positions.

It would be a needless labour, and a wearing out of the patience of this meeting, to attempt to go through all the calculations required to come to the results intended to be laid before you; but your attention is requested to the following, as an example of the process required to be gone through in each case.

In Beam No. 1, the depth of the bottom flange is 0·4 in., and the assumed depth from under edge to neutral axis is 4·0 in. Suppose the beam below the neutral axis, divided into parts equal to the depth of the thickness of the flange, we will have 10 of these, the web occupying the upper 9, and the flange the 10th. The proportionate amount of strength contributed by each of these parts, is as the square of the distance of the part from the neutral axis. The distance of the centre of the upper part is $\frac{1}{2}$, and the square of this is $\frac{1}{4}$, and let us call the amount of strength contributed by this upper part $\frac{1}{4}$. The distance of the centre of the second part $1\frac{1}{2}$, and the square of this is $2\frac{1}{4}$, so that, in the same proportion, the amount of strength contributed by this part is $2\frac{1}{4}$; and so on, until we reach the 10th part, or part of the flange immediately under the web, the amount contributed by which in the same proportion is $90\frac{1}{4}$. If we sum this series, we shall find that the whole strength due to the 10 parts of 4·0 in depth is $332\frac{1}{4}$, $90\frac{1}{4}$ of which is contributed by the 10th or lowest part, and the rest $242\frac{1}{4}$ by the web.* But we have to take into account the whole flange. The flange being at the same distance from the neutral axis as the lowest or 10th part, it will contribute in the same proportion as that part to the strength of the beam. Now, the breadth of the flange is 1·75 in., or 5·83 times the thickness of the web, so that we have the proportionate strength due to it ($5{\cdot}83 \times 90\frac{1}{4} =$) 526·16. Add this to the proportion of strength due to the 9 parts of the web, namely 242·25, and we have the proportional strength of the whole Beam, 768·41.†



The actual strength of this Beam, as reduced to one standard, is, as already seen, 2509 lbs. per square inch of section. By dividing this into the proportions just stated, we shall get the amount contributed by the web to be $\left(\frac{242}{768} \times 2509 = \right)$ 791 lbs., and the amount contributed by the flanges to be (2509—791 =) 1718 lbs.

* We get the same results more simply and more precisely, by taking the cubes of the respective depths from the neutral axis; thus, $10^3 : 9^3 = 1000 : 729 = 332 \cdot 5 : 242 \cdot 39$, and $332 \cdot 5 - 242 \cdot 39 = 90 \cdot 11$, as above, very nearly.

† Perhaps it is unnecessary to remind any, that the strain of tension on the part of the Beam, below the neutral axis, is equal in amount to the strain of compression on the part above it, and that therefore this latter does not require to be calculated, it being sufficient, in comparing the strength of Beams, to assume the whole strength of the Beam as depending on the resistance to extension.

We have now to consider the alteration on these quantities produced by reducing the thickness of the web, and by adding the metal taken from it to the flanges.

As Beams, Nos. 12, 19, 20 and 21, being those of best section according to Mr. Hodgkinson's experiments, have, on the average, webs of about one-fourth of their sectional area, we shall take this as the quantity to which, for comparison, all the webs are to be reduced. We have then, in Beam No. 1, the area of the cross section, 2·82 ins., of which the flanges occupy 1·425 in., and the web 1·395 in. The area of the web will now be one-fourth of 2·82 in., that is, 0·705 in., being a reduction of 0·690 in., which has to be added to the area of the flanges, making it (1·425 + 0·690 =) 2·115 in.

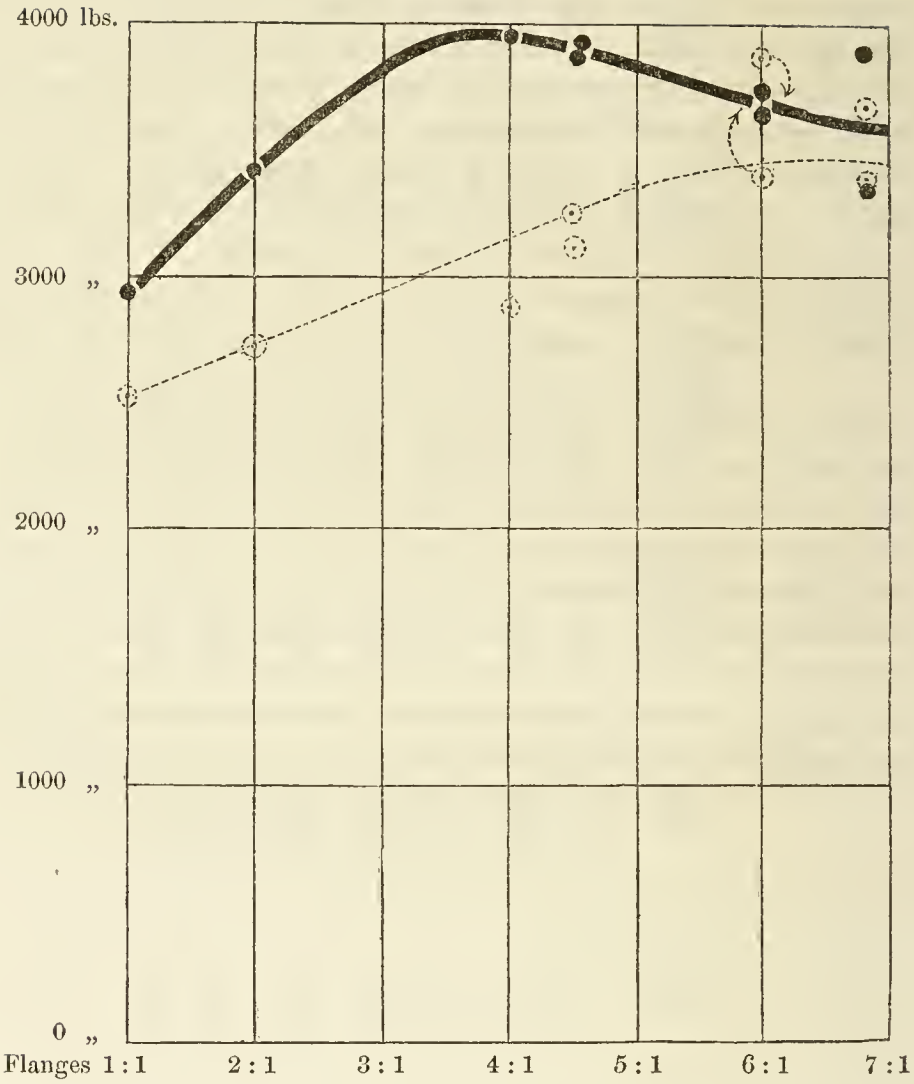
By this alteration in the section, we reduce the amount of strength contributed by the web by $\left(\frac{0{\cdot}690}{1{\cdot}395} \times 791 = \right)$ 391 lbs., while we increase the amount of strength contributed by the flanges by $\left(\frac{0{\cdot}690}{1{\cdot}425} \times 1718 = \right)$ 832 lbs., which gives an increase to the strength of the beam equal to the difference of these two quantities, namely, 441 lbs., making the strength of the Beam, No. 1, altered so as to have the web one-fourth of the sectional area to be 2950 lbs. per square inch of cross section, instead of 2509 lbs.

If the same process be gone through with all the Beams, we shall have the results as given in Table III.

TABLE III.

No. of Beam.	Proportion of Flanges.	Area of Cross Section.	Area of Flanges.	Area of Web.	Proportion of Web to Cross Section.	Strength per Square Inch reduced to one Standard.	Difference on account of thickness of Web.	Strength per Square Inch, when Web reduced to $\frac{1}{4}$th Cross Section.
1	1 : 1	2·82 in.	1·425 in.	1·395 in.	0·494 : 1	2509 lbs.	+ 441 lbs.	2950 lbs.
2	2 : 1	2·87 „	1·43 „	1·44 „	0·501 : 1	2720 „	+ 703 „	3423 „
3	4 : 1	3·02 „	1·52 „	1·50 „	0·496 : 1	2900 „	+ 1050 „	3950 „
9	$4\frac{1}{2}$: 1	3·37 „	1·927 „	1·443 „	0·427 : 1	3121 „	+ 760 „	3881 „
11	$4\frac{1}{2}$: 1	4·50 „	2·70 „	1·80 „	0·400 : 1	3268 „	+ 642 „	3910 „
12	6 : 1	5·00 „	3·38 „	1·62 „	0·324 : 1	3402 „	+ 343 „	3745 „
19	6 : 1	6·40 „	5·12 „	1·28 „	0·200 : 1	3867 „	− 229 „	3638 „
20	$6\frac{3}{4}$: 1	6·50 „	4·95 „	1·55 „	0·238 : 1	3394 „	− 47 „	3347 „
21	$6\frac{3}{4}$: 1	5·41 „	3·808 „	1·602 „	0·296 : 1	3685 „	+ 208 „	3893 „

Diagram II.



On Diagram II. the large dots and curved line represent to the eye the same results, and the nature of the law which they follow, while the small points within the dotted circles, and the dotted curve, are the same as those shown on Diagram I. On examination it will be seen, that the result of our investigations, in so far as refers to the strongest section of Beam, is that with the web one-fourth of the sectional area; this is obtained with flanges rather under 4 : 1.

Before proceeding further, we may notice, as a corroboration to some extent of the correctness of these investigations, first, that in the two pairs of experiments, Nos. 9 and 11, and Nos. 12 and 19,

the results, after the required corrections are made, approximate very closely, the former so as almost to coincide; and secondly, that all the results (with the exception of the last) arrange themselves so as to allow the curve to follow them almost exactly. In the case of the last pair of Beams, Nos. 20 and 21, the discrepancy is increased by the corrections made; but still it is satisfactory to notice, that the curve follows nearly the average of the two. As to this discrepancy, it perhaps arose from some inequality in the castings, or some other of those causes alluded to in the former part of this paper; but the effect has doubtless been increased by the lowness of the neutral axis. This was probably about $1\frac{1}{2}$ inch from the under edge of the Beam, giving the effective leverage of the flange round the neutral axis as $1\frac{1}{4}$ inch on the average; so that any small difference on the quality of the metal, or any other cause affecting the position of the neutral axis, would give a comparatively greater difference in the strength of the beam than would have been, if the neutral axis had been higher.

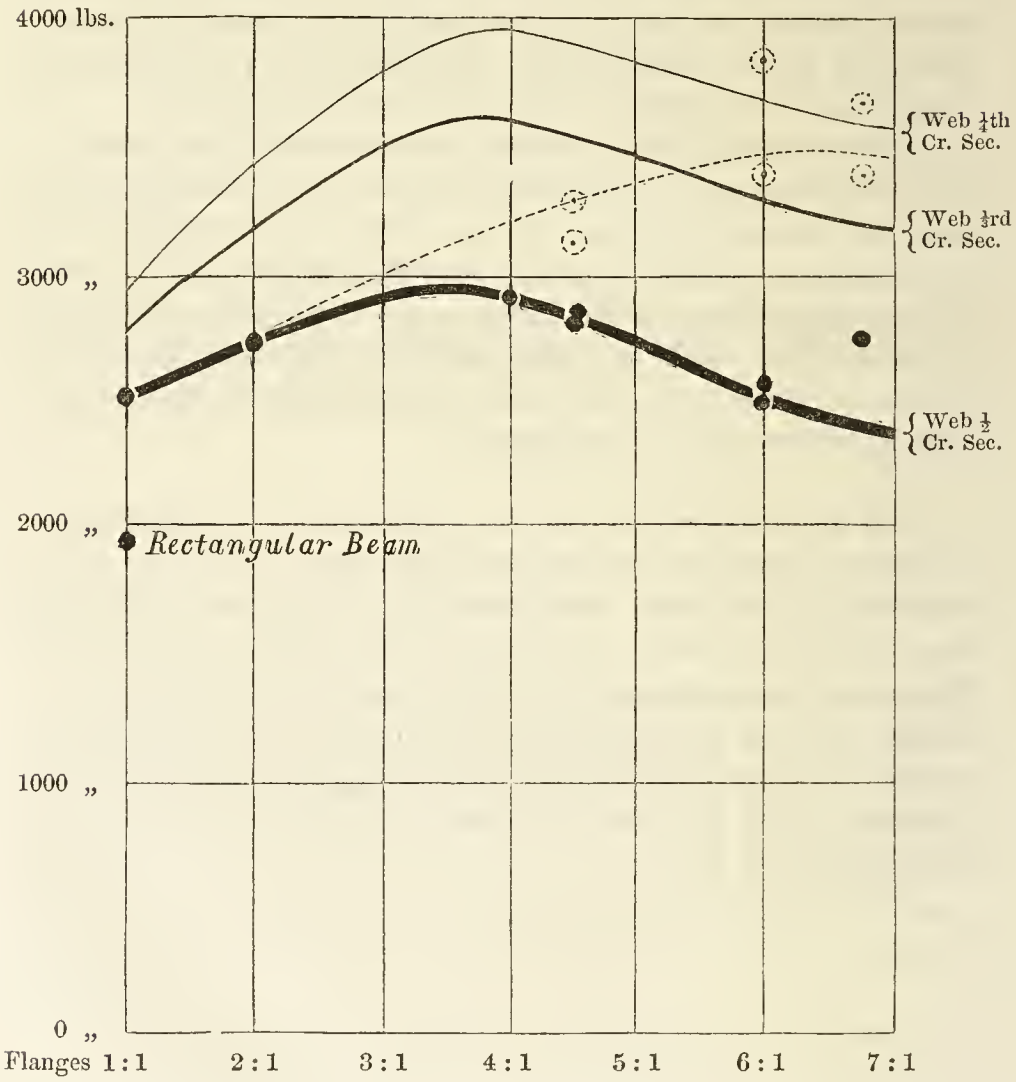
These remarks point to another corroboration of the investigations in this paper. In experiment 19 and 21, the fractures indicated the neutral axis to be 1·23 and 1·80 inches from the under edges of their respective Beams. Now this seems to indicate, that if by a comparatively small addition to the upper flange, by which the neutral axis would be considerably raised, the strength of the Beams would thereby be increased much more than in the proportion of the amount of metal added.

The foregoing calculations have been made on the assumption of the web being one-fourth of the cross section, as that was about the average of the webs of the Beams of strongest section, according to Mr. Hodgkinson. I have also calculated the strength of the Beams, on the assumption of the web being one-half of the cross section, which is the proportion in the case of Beams, Nos. 1, 2, and 3. The result is given in Table IV. and Diagram III., which indicate, that in this case the Beam of strongest section is that with flanges $3\frac{1}{2}:1$.

TABLE IV.

No. of Beam.	Proportion of Flanges.	Strength per Square Inch reduced to one Standard.	Difference on account of thickness of Web.	Strength per Square Inch when Web reduced to $\frac{1}{2}$ Cross Section.
1	1 : 1	2509 lbs.	— 0 lbs.	2509 lbs.
2	2 : 1	2720 „	— 0 „	2720 „
3	4 : 1	2900 „	— 0 „	2900 „
9	$4\frac{1}{2}$: 1	3121 „	— 305 „	2816 „
11	$4\frac{1}{2}$: 1	3268 „	— 428 „	2840 „
12	6 : 1	3402 „	— 816 „	2586 „
19	6 : 1	3867 „	— 1371 „	2496 „
20	$6\frac{3}{4}$: 1	3394 „	— 1098 „	2296 „
21	$6\frac{3}{4}$: 1	3685 „	— 917 „	2768 „

DIAGRAM III.



I have also laid down, on the same diagram, the curve representing the comparative strength of Beams, with different proportions of flanges, when web is one-third of the sectional area.

TABLE V.

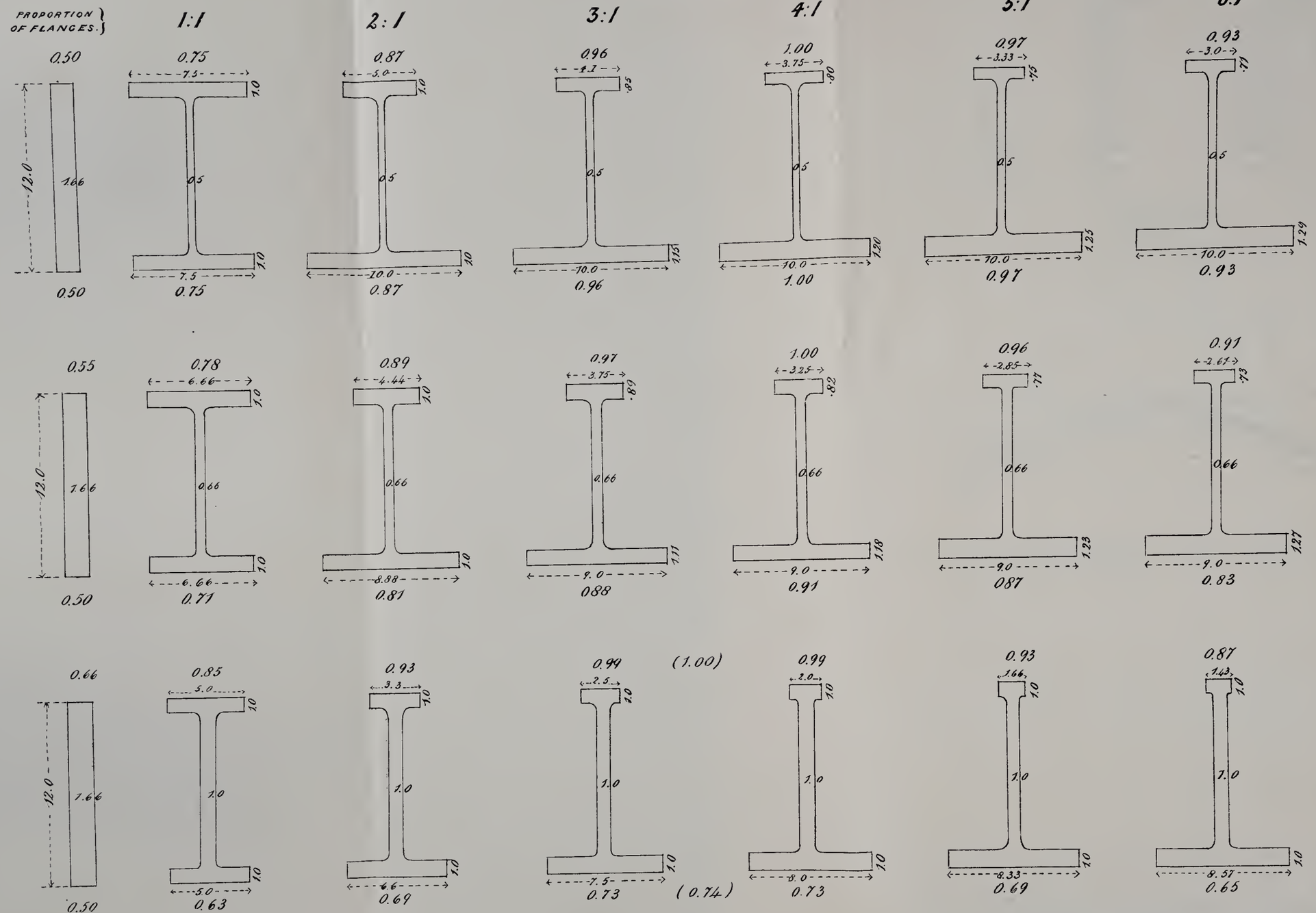

PROPORTION OF FLANGES.
1:1
2:1
3:1
4:1
5:1
6:1
0.50
0.75
0.87
0.96
1.00
0.97
0.93
12.0
1.66
0.5
7.5
10.0
3.75
3.33
3.0
0.80
0.85
0.75
0.71
1.20
1.25
1.29
0.55
0.78
0.89
0.97
1.00
0.96
0.91
6.66
4.44
3.75
3.25
2.85
2.67
0.66
0.89
0.82
0.77
0.73
8.88
9.0
1.11
1.18
1.23
1.27
088
0.87
0.66
0.85
0.93
0.94
(1.00)
0.99
0.93
0.87
5.0
3.3
2.5
2.0
1.43
1.66
1.0
6.6
7.5
8.0
8.33
8.37
0.63
0.69
0.73
(0.74)
0.65

Table V. has been prepared for the purpose of getting the assistance of the eye, in forming a judgment on the comparative eligibility of the various sections of Beams. The depth and area of cross section are the same in all; the upper row has the area of the web one-fourth of the cross section, the second row one-third, and the third row one-half of the cross section — a rectangular Beam of the same area being placed alongside each row, for the sake of comparison. The depth of the Beams is 12 units of any kind. The area of cross section will then be 20: the figures above the Beams give the comparative strength of each, the Beam of strongest section for each particular row being taken as unity. The figures below the Beams give the strength of each, the Beam of strongest section in the upper row, that is, with the web one-fourth of the cross section being taken as unity. It may be noticed, that there were no experiments by which the exact comparative strength of the rectangular Beam could be determined. The strength in the table is therefore given in round numbers, being only approximative, for the purpose of giving some idea of the strength of a Beam without flanges, as compared with those with flanges. The correct strength, however, is probably nearly 5 per cent. less than that stated.

On examination of these respective sections, I think it will be generally considered, that the web, one-fourth of the sectional area, is too thin for ordinary practical purposes. On the other hand, the web, one-half of the sectional area, appears to me to be unnecessarily thick; whereas the web one-third of the sectional area seems to be more nearly of a proper proportion. In Beams, where the depth is greater in proportion to the sectional area than that here assumed, it might thin the web too much to retain this proportional area of one-third. In this case, it would be necessary to increase the proportion of the web; but probably in no case would it be necessary to do so to a greater proportion than one-half of the sectional area.

On examination of the curves on Diagram III., it will be seen that there is very little difference in the strength of Beams on each side of the maximum. Now, as it is generally desirable, for other reasons, to have the flanges of more equal proportions than those of maximum strength, it will be advisable to consider, in the case of Beams with web one-half of the sectional area, the strongest section to be that with flanges 3 : 1, instead of $3\frac{1}{2}$: 1, and in the case of Beams with web one-fourth of the sectional area, the

strongest section to be that with flanges $3\frac{1}{2} : 1$, instead of about $4 : 1$.

From these considerations we come to the conclusion, that for general purposes, THE MOST ELIGIBLE SECTION OF BEAM IS THAT HAVING A WEB FROM ONE-THIRD TO ONE-HALF OF THE SECTIONAL AREA, AND FLANGES FROM $3\frac{1}{2} : 1$ TO $3 : 1$, according to circumstances.

There are some things, arising out of these investigations, which I felt desirous of laying before this meeting, such as, rules for calculating the strength of Beams, taking into account the proportions of both flanges and web, neither of which Mr. Hodgkinson's rule does; but I have been prevented by ill health from entering into these investigations so thoroughly as to be satisfactory; and besides, this paper has probably stretched out to a sufficient length for the present. Perhaps I may have the honour of submitting some further remarks to the Institute on a future occasion.

The investigations and calculations of this paper have been founded wholly on the experiments of Mr. Hodgkinson. I have not the slightest reason for doubting the accuracy of these, as they seem to have been made with the utmost care, and are most minutely detailed; yet having come to different conclusions from those of the author of the experiments, it would be satisfactory to have these conclusions tested by a set of experiments arranged specially for the purpose of fixing the law of variation in the strength of Beams of different sections.

I have therefore respectfully to propose, that this should be taken up by the Institute.

In the case of it being agreed to do so, I have to suggest, that the experiments be made with Beams cast from carefully formed patterns, so as to be exactly of the under stated dimensions and proportions — all the Beams to be 5 feet long and 5 inches deep, and of exactly the same sectional area, and to be tested at a bearing of 4 feet 6 inches. The first Beam to be rectangular, the second with flanges $1 : 1$, the web of this, as of the following, being one-third of the sectional area, the other Beams to have flanges in the respective proportions of $2 : 1$, $3 : 1$, $4 : 1$, $5 : 1$, and $6 : 1$. There ought to be at least three castings of each, so as to obtain the average, and to avoid exceptional cases.

Transactions of the Architectural Institute of Scotland,
Session 1855-56.

No. V.

ON THE LAYING OUT

OF

OPEN SPACES IN TOWNS.

BY

JOHN MURRAY, Esq.

ADVOCATE.

[*Read at a Meeting of the Institute in Edinburgh, on 18th February* 1856.]

It has for some time been acknowledged to be highly desirable, in a sanitary point of view, that there should be within large towns open spaces of ground unoccupied by buildings. Such are our Gardens, Squares, Crescents, and Places. They are beneficial not only to the inhabitants of the rows of houses to which they belong as accessaries, but to the dwellers in more crowded streets, who use them as thoroughfares or places for walking and recreation. I do not now speak of parks or extensive grounds which are outside or on the outskirts of towns.

There would seem, however, to be reason for doubting whether such open spaces of ground have been always laid out in the best and most suitable manner. They are designed to be ornamental as well as salutary to health. They are immediately under every one's observation, and if not well laid out, they either offend the eye or become objects of indifference. To ornament the ground fronting or surrounding a great mansion, an hospital, or a villa, is now a department of practical art highly cultivated, and affording scope

for the application of certain principles of taste. But to ornament the ground fronting rows of lofty stone houses in a town, sides of squares built frequently on uniform plans of architectural design, or ranges of buildings including amongst them houses which in other countries would be called "palaces," has been, until recently, considered a matter of so little importance as to be left in the hands of apparently very commonplace gardeners.

When proposing to lay out and decorate spaces or portions of ground within towns, our predecessors have generally had in view an imitation of the country and of garden scenery. This was particularly the case in London, probably long before there was a square or crescent in either Edinburgh or Glasgow. Men congregated together and pent in populous cities have a certain pleasure in rural associations, and a desire, sometimes speculative or theoretical, for the enjoyment of the beauties of the country. They long for the freshness of fields, the verdure of grass, the noble forms of trees, the beautiful and varied colours of plants and flowers. This feeling, perhaps implanted by nature, has been given expression to by Horace in one of his Epistles, addressed to an inhabitant of Rome, in praise of a country life —

"Nempe inter varias nutritur silva columnas,
Laudaturque domus longos quæ prospicit agros.
Naturam expellas furca, tamen usque recurret,
Et mala perrumpet furtim fastidia victrix."

"Amidst the varied columns you so prize,
Umbrageous groves with studied art arise:
The house is lauded whose position yields
An open prospect to the lawns and fields.
For Nature, driven off with proud disdain,
Victorious goddess, still returns again."

But when it is endeavoured to clothe this sentiment with a reality — to give a local habitation to this ideal *rus in urbe*, our efforts, however praiseworthy, have not been very successful. While Edinburgh, for instance, abounds with situations where noble prospects of natural scenery, both distant and more near, are to be had, the home views which its leading Squares and Places present are distinguished by a certain tameness and poverty of appearance. This observation does not apply, at least not in the same degree, to the large gardens fronting Princes Street and Queen Street. But who could discover in the interior of the Squares, either of London or Edinburgh, the beauty of a dressed lawn or of a garden? The stunted shrubs, dingy grass, scrubby evergreens, and winding gravel walks, which are their staple scenery, are but shabby materials for what professes to be an imitation of rural nature. Nor is their beauty much enhanced by the too frequently paltry parapet and railing by which they are surrounded.

With all this in view, the doubt inevitably arises, whether the proprietors or other parties who have directed the laying out of those squares and places, have not allowed themselves to be carried too far by the desire of imitating what is perhaps improperly called "natural scenery," as displayed in the modern park and extensive garden. We may approve or not of the "natural" system of landscape gardening, with its clumps and shrubberies and winding walks, when applied on an extensive scale to parks, lawns, and spacious garden ground; but surely it is unnecessary to apply the same rule to the laying out of a comparatively small and limited space of ground, surrounded by houses of which it is an adjunct.

When the space is large, particularly where it is much longer than broad, as in the Edinburgh Queen Street Gar-

dens, and where the ground slopes and is otherwise irregular and naturally picturesque, as in the West Princes Street Gardens, then probably the best occupation of such ground is the spacious garden enclosure, but on a large, handsome, and somewhat park-like scale. Where the space is more limited and dependent upon the buildings in its immediate neighbourhood, then I would very humbly submit, that the laying out of such space should be of an architectural character, in harmony with the buildings of which it is an appendage. This foreground to the houses of our squares and places might be termed artificial—but it is not more artificial than the houses themselves. It might be termed formal—but the mode in which the central spaces are at present laid out, is also formal, though in a different way. The one would be what has been well called "an avowed and characteristic formality," while the other is a formality not less real, but whose undisguised baldness has no air of decoration to raise its character. As an example, to a certain extent, of this manner, and as a step in the right direction, I would point to the East Princes Street Garden of Edinburgh as recently laid out. The terrace walk, fronting Princes Street, with its stone ledges, flights of stairs, and balustrades, continuing the effect of the terrace to the garden ground below, is handsome and more congruous in its bearing on Princes Street, than the terrace walk of the West Gardens of the same street, which is comparatively narrow and unadorned, though agreeable in summer from the shade of the trees.

The particular manner in which individual open spaces of ground should be laid out must depend greatly on the circumstances of their locality. And there are other circumstances bearing materially on the subject, such as consent of house proprietors, feuing plans, and cost of work,

which it is also necessary to keep in view, so far as that what is now suggested should not be of an impossible, extravagant, or Utopian description. Not losing sight of these considerations, the indulgence may perhaps be granted to me of attempting to point out certain general characteristics of the architecture of the principal Squares and Places, which would seem to be of such importance as to render it advisable that they should enter as elements into the manner and style of laying out the ground in front. These characteristics are—1. Regularity, and as a rule, an adherence to straight lines. 2. A general proportion and symmetry of parts. 3. The material of the buildings, which in Edinburgh and Glasgow is stone, and along with this the greater or less amount of architectural ornament on the fronts of the ranges of buildings.

(1.) Straight lines and angles are of the essence of architecture; and even where it deals in curves, they are regular and uniform. In the case of a crescent, its regular sweep affects the whole range of building; but generally speaking, curved lines are confined to the less essential parts, such as pillars, the tops of windows, &c. It would seem to follow from this, that the struggle to imitate the waving lines of natural objects in the laying out of ground, as part and parcel of the buildings which adjoin it, is at variance with sound principles of taste. For it will hardly be disputed, that the accessory should partake of the character of the principal, and therefore that straight lines and regularity ought to be leading features in what may be called town-gardening, in order to bring it in harmony with the buildings it accompanies.

(2.) A general proportion and symmetry of parts is another characteristic of architecture, which is too often forgotten in laying out the adjacent ground. Little cir-

culating walks with pared edges or boxwood borders, narrow shrubberies, small flower borders and common iron railings, may no doubt agree with one another; but it is questionable whether they are symmetrical appendages to rows of massive buildings, to Palladian façades, and orders of columns. While stunted shrubberies are decidedly objectionable, well set-down trees are in keeping with such architecture. In some parts of the New Town of Edinburgh, where the planners of the ground had the good taste to leave old and growing trees where they could be allowed to stand, incongruity is avoided, or at least the incongruous objects are less noticed. Trees of a handsome growth, particularly if in straight lines, when planted in a well-kept lawn with broad walks, are not only ornaments in themselves, from their symmetry and size, but, when not too close to the houses, add to and enhance their effect. They are, besides, useful and pleasant from the shade they afford. What can be more agreeable and appropriate than in Kensington Gardens to see elderly gentlemen, nursery-maids and children

> "Under the shade of melancholy boughs
> Lose and neglect the creeping hours of time?"

It may be said, that trees are of slow growth, and to make an alley of elms or limes would be a tedious matter. So far this is true; but improvers and ornamental gardeners must look to the next generation as well as to the present; and a well-planted alley of trees, though young, carries the mind forward in some sort to their future growth and size. Besides, transplanting is now brought to such perfection, that trees of considerable size may be transferred to particular localities without much difficulty or expense.

Whether trees are planted in alleys or in groves with evergreens, sufficient care cannot be taken in attending, upon

a uniform plan, to their progress each successive year, thinning out and digging round the roots. If quick growing trees and nurses, such as poplars and willows, are put in along with the better sort of timber trees, they should be taken away at the proper time, and not allowed to overtop and choke up, as is frequently the case, the very trees they were intended to shelter and bring on.

(3.) The material of which the houses of Edinburgh and Glasgow are built is stone, the fronts being in general highly finished and polished. And this feature of their architecture, as distinguished from that of most of the London squares and places, appears to demand, in the manner of laying out the ground which is to correspond with them, a more solid, finished, and determinate character. It is not in every situation that a terrace-walk, understanding thereby a walk on the summit or side of a slope, can be introduced. Where it can be suitably introduced, as on the south side of Princes Street, the whole extent of both gardens, there it ought to be, with its parapets and ledges of stone work. Where the situation is not adapted for a proper terrace, some use of stone would still seem to be necessary, in order to make a harmonious whole with the buildings. Discarding the narrow gravel walk with its boxwood or pared border, what may be termed a terrace walk—that is, a broad gravel walk with polished stone boundaries, more or less ornamented, carried through a well-kept grass lawn, would then be a principal feature of the dressed ground. I cannot give a better idea of such a walk than is contained in the following passage from one of the essays of Sir Uvedale Price;* —

"I have already," says he, "mentioned the superiority of the terrace walk in its simplest state with a mere parapet,

* Vol. ii. p. 136.

over the gravel walk, with its pared edge of grass as an immediate foreground; and it is clear, that one cause of that superiority is the contrast between the colour of stone and the tints of vegetation. The inferiority of the gravel walk in such a situation proceeds likewise from another circumstance; its boundary is not only meager as well as formal, but is incapable of receiving any ornament, or of being varied with any effect. The parapet, on the contrary, admits of a great degree of ornament, and also, what is very material, of a mixture of the light and pliant forms of vegetation with the uniform unbending substance of stone and the enrichment of the sculptor. Should the solid wall be thought too heavy, a balustrade, without destroying the breadth, gives a play of light and shadow of the most striking kind. On the top of the coping, urns, flower-pots, &c., of every shape and size, find their place. Climbing plants might add their loose festoons to those imitated in sculpture, and vases of elegant forms, as well as the plants contained in them, would add to the general richness and variety."

Such a walk, it is obvious, may be more or less decorated according to circumstances. Seats of polished stone, basins of stone for water, parterres of flowers bounded with stone ledges, would likewise be suitable details in dressed ground of the kind now referred to. "With respect to fountains and statues," it is observed by the authority above cited, "as they are among the most refined of all garden ornaments, so they are most liable to be introduced with impropriety." In architectural gardens of a high class, such as the Thuilleries, they are in their proper place. Where there is no great extent of ground, as in some situations in Edinburgh, it may be suggested whether, so far as architectural effect is concerned, there ought to be an enclosure at all; and instead of being enclosed, whether the spaces

should not be laid down with stone pavement. A spacious pavement of stone has of itself an excellent effect in combination with architecture. And the circulation of air would be greatly improved by the want of the paltry clumps of planting which are sometimes seen in confined localities. To avoid a blank appearance, however, as well as for the convenience of foot passengers crossing, it might be requisite in such paved places, that there should be something in the centre to break and make a principal point in the space. Whoever has visited the chief continental towns will recollect the number of unenclosed places of no great extent, which have almost all of them a statue, an obelisk, or a fountain in the centre. The occasional alleys of trees at Berlin, the Hague, Frankfort, Paris, &c., will also be remembered. As a substitute for something better, the large lamp in the space at the west end of Princes Street is well suited to that particular situation. A well-constructed fountain, in the Flemish or German style, with open stone basin, in the middle of the Grassmarket of Edinburgh, would be adapted to the site and very beneficial to the neighbourhood.

In one of the open spaces in Edinburgh, and not one of very great extent, St. Andrew's Square, there is already in the centre a piece of architecture of important character and of a known and classical type. For various reasons this would seem to be a situation peculiarly suited for the treatment just proposed, viz., that it should be converted into a stone-paved open place. The present enclosed ground, encircling the Melville column, with its parapet and railing neither handsome enough to be ornamental nor light enough to be unnoticed, is quite unworthy of the locality. The architecture of the adjoining buildings is becoming every day richer and more decorated, and the thoroughfare is one

of the principal in the town. Nor is the slope in the area of the square from south to north so great but that it might be corrected by a skilful management of the ground.

With these observations, which are mere suggestions, the matters imperfectly treated of in this paper must be left in the hands of the proprietors of houses and public bodies more immediately concerned.

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No. VI.

ON

THE EGYPTIAN OBELISKS

NOW IN

ROME.

BY

ALEXANDER THOMSON, Esq.

BANCHORY.

[*Read at a Meeting of the Institute in Edinburgh, held on 3rd March* 1856.]

The erection of masses of stone in commemoration of important events, or in honour of distinguished persons, is coeval with the first beginnings of civilization in almost every country — the first attempt to establish historical records.

We find incidental notices of such monuments at an early age in Scripture; and we have the monuments themselves, of great antiquity, still existing in many countries as well as in our own, where they appear in the form of those sculptured stones, whose inscriptions will, we trust, soon be made to reveal the story of their erection.

It is a doubtful question, whether the stone set up, or the inscription engraven on the rock be the more ancient; probably for many ages they were contemporaneous, at least this appears to be the conclusion pointed out by the recent

progress of discovery, and they often mutually illustrate each other.

The object of this paper is to describe to the Institute one class of these monuments as now existing in Rome — the Obelisks — monuments which never fail to attract the attention of even the most careless traveller.

They have features, and produce an effect wholly peculiar to themselves; and though they have stood in Rome from sixteen to eighteen centuries, they are still manifestly foreigners, having no natural connection with the scenes around them.

The Romans never displayed much original or natural genius for any department of the fine arts. Their whole mental history shows them to have been in these matters copyists and not inventors. Their dramatists copied or translated from the Greek. Their orators imitated Demosthenes and Æschines, and enforced the study of them, and not that of any Roman models, on those who wished to excel in the art of public speaking.

In Architecture also, to a large extent, they were mere servile imitators; their principal buildings, down to the age of the emperors, being close, but not perfect copies of Grecian models.

In regard to the "Fine Arts," in the more restricted use of the term, they followed even a simpler plan than that of copying — they carried off the objects themselves to adorn their capital. An early instance of this occurs on the taking of the Etruscan city of Volscinium (now Bolsena), from which two thousand statues are said to have been carried to Rome (in B.C. 265, A.R. 488), which are reported to have been the first seen in the city.

We may also fairly infer the low state of public taste at a later period, from the well-known story of the Consul

Mummius, the conqueror of Corinth (B.C. 146, A.R. 607), who so little valued the inestimable works of art with which Corinth abounded, that he sold the finest of them to the King of Pergamus; and on shipping the remainder to Rome, he *exacted security* from the ship eaptain to replace whatever pictures or statues might be lost or injured during the voyage.

The Romans, in truth, appear to have had, for many centuries, only a general indiscriminating admiration of works of art, as ornamental, and nothing more, without entering into the spirit or appreciating the principles which gave them birth.

This is the more remarkable, beeause their predeeessors, the Etruseans, had attained great excellence in sculpture and the fietile arts; and their productions were highly esteemed and carefully sought out under the emperors; but for several eenturies suceeeding their final subjection, their arts seem to have been wholly despised and forgotten by their conquerors.

The Romans were especially a fighting and governing people, and all their delight was in those pursuits which enabled them first to subdue and then to rule with advantage their acquired dominions. The whole vigour of Roman intellect was given to the arts of war and of government during the long period of the growth of their empire, and whatever attention was bestowed on other subjeets was plainly held to be of very seeondary importance.

It was far otherwise in Greeee. There the fine arts grew with freedom; they arose from it, and were to a large extent its beautiful expression; while in Rome the arts flourished as liberty decayed. Architeeture is the only branch whieh can be said to have been a national taste, and even what of it is strictly Roman eame into existence after freedom

had been well nigh extinguished, and grew into grandeur and magnificence, not as the liberty and happiness of the nation increased, but as the power and wealth of the emperors waxed greater and greater, and reached its culminating point of magnitude, though not of taste, in the days of Caracalla and Diocletian.

The early Romans however, as we have said, were not altogether insensible to the beauties of art; and if they had not genius to produce, they had power to seize and to transport to Italy the finest specimens which the known world could furnish. Some of the earliest examples of this system of spoliation have been quoted, and it continued so long as Rome continued to conquer. Whatever was beautiful in vanquished cities, if only portable, was conveyed to the capital, and was used, if practicable, first to adorn the cruel triumphal procession, and permanently to ornament one or other of the various places of general resort, where they served the double purpose of gratifying the public eye, and of stirring up the minds of youth to farther acts of conquest and of spoliation, that they too might, in their turn, contribute to the adornment of the capital of the world.

When Egypt was conquered, it was natural that the beautiful obelisks should excite the cupidity of the victors, and that they should desire to convey them to their own capital, both as objects worthy of all admiration, and as most enduring trophies.

They employed them in various ways. Many of them were set up on the Spinæ of the principal circuses, where latterly they seem to have been regarded as almost indispensable ornaments.* Two were placed in front of the

* "Et mediis centri summus obeliscus abit."—Epigr. de Circensibus, quoted by Hoffman.

Mausoleum of Augustus, and one was employed as the gnomon of an enormous sun-dial.

We learn from Publius Victor, that at one time forty-eight existed in Rome, six of the largest size, and forty-two smaller.* The first of these was imported by Augustus, and the last by Constantius, during a period of rather more than three centuries. Of the forty-eight, twelve only now remain erect in Rome; but fortunately several of them are of the largest size. Of the other thirty-six, one is now at Florence, one in France, one or two are known to exist under the earth in Rome, especially one under the Church of the Jesuits, of large size, but which cannot be extracted without pulling down a corner of the church, and the greater part of an adjoining palace. It is probable that the remaining thirty-two are still more or less safely covered up amid the ruins of ancient Rome, and may yet repay the labour of the excavator. They are formed of a most durable material, not easily injured, even wilfully, and not liable to decay. Most of those found have indeed been broken, but the fractures are the evident result of their fall; and it is satisfactory to know, that we possess the finest of them all in a state of almost perfect preservation.

The ancient Romans must have had an intense admiration of these obelisks, for they conveyed them at enormous expense from the banks of the Nile to the banks of the Tiber, and in this they deserve all credit for their taste.

There is no form more perfect, no outline more beautiful, than that of an obelisk. View it in whatever direction we may, its figure is complete, and the material of which those brought to Rome is composed, leaves nothing to be desired.

* Publius Victor de Regionibus.

So far as we know, they were all extracted from the large grained red granite quarries of Syene in Upper Egypt. This rock, termed "Syenite" by mineralogists, is so named from these quarries, and it is distinguished from common granite, by containing hornblende in place of mica. But granite and syenite can scarcely be distinguished from each other by the general appearance, and in the rocks the component parts vary, and both granite and syenite in many varieties occur at Syene. A similar rock occurs in our own and in many countries, but nowhere of the same brilliant colour, nor in the same gigantic masses.

A genuine obelisk is a monolithic monument of four equal sides, tapering very gradually from the base upwards, and generally terminating in a pyramidion, though in a few instances the termination is flat, and occasionally the sides are not equal, but two of one size and two of another. The proportions vary considerably, and it may be they were partly determined by the form of the stone as first obtained from the rock; it was desirable to make use of every portion, and hence in some the terminating pyramidion is very long, and in others very short, in proportion to the shaft. It is thus defined by Am. Marcellinus — "Est autem obeliscus asperrimus lapis, in figuram metæ cujusdam sensim ad proceritatem consurgens excelsam; utque radium imitetur gracilescens, paulisper specie quadratâ in verticem productus angustum manu levigatus artifici." — *Am. Marcellinus*, xvii. 4.

It has been supposed, that the original idea of an obelisk was to represent a ray of the sun's light, or a flame, and both the form and the material correspond with the idea. The Greek word ὀβελισκος, a diminutive from ὀβελος, a spit, points to a less poetic origin, and even the

word οβελισκος is thus used by Diodorus Siculus (v. 28) in describing an Egyptian dinner,* and in another place he uses the word in a totally different sense, as a pipe or conduit, when describing a great flood at Rhodes.†

The warm red colour of the granite of Syene is completely associated in our minds with the idea of an obelisk. We can hardly think of it as formed of any other material, and certainly no other produces the full genuine effect.

The obelisks were admired by all strangers who visited Egypt, and even the ruthless destroyer Cambyses is said to have been so struck by the exquisite beauty of one of those at Thebes, that he spared it alone of all the monuments of that glorious city.‡

The mysterious characters engraven upon them attracted the attention of intelligent travellers, and it is curious to notice how, from the time of Herodotus downwards, the Egyptian priests seem to have carried on a regular system of mystification, and sent home the inquisitive Greeks and Romans, crammed with information, all tending to exalt the glory of Egypt and the Egyptian priesthood, with little regard to historic truth and accuracy.

The notices of obelisks in the Latin classics are few and slight. Although Egypt was reduced to a Roman

* "Και λεβητας εχουσι και οβελισκους πληρεις κρεων ολομερων."

"Ollisque ac verubus, quæ integrorum carnibus membrorum referta sunt, instructi." — Diod. Siculus, v. 28.

† "Των δε εν τοις τειχεσι οβελισκων συμφραχθεντων."

"Et tubis murorum obstructis." — Ibid. xix. 45.

‡ "Hac admiratione operis effectum est, ut cum oppidum id expugnaret Cambyses Rex, ventumque esset incendio ad crepidines obelisci extingui ignem juberet molis reverentia qui urbis nullam habuerat."—Pliny, Hist. Nat. xxxvi. 9.

province by Augustus, none of the authors of his age, so far as we can find, take the least notice of the noble monuments he brought from thence to Rome. Our information regarding them is all derived from subsequent writers and from the inscriptions on themselves.

The art of quarrying out and erecting obelisks, and sculpturing hieroglyphic inscriptions upon them is of great antiquity in Egypt, ascending up to a very early period of the monarchy, beyond the times of other records; and the precise dates remain to be yet determined by the decypherment and interpretation of the sculptures on the monuments themselves. The removal of the blocks from the rock seems to have been accomplished by wedges, for their marks still remain in the quarries. Herodotus attributes the first obelisks to *Pheron*, who erected two at the Temple of the Sun, in gratitude for the restoration of his sight, each of one stone, 100 cubits long and 8 cubits broad.* Pliny gives the name of *Mitres* to the first maker of an obelisk, and declares he had been commanded to do so in a dream.†

Ammianus Marcellinus says, that the hieroglyphics contained the principles of ancient wisdom, and adds, that single characters expressed nouns and verbs, and sometimes entire sentences.‡ Pliny states, that the hieroglyphic

* "Οβελους δυο λιθινους, ἐξ ἑνος ἑοντα εκατερον λιθου, μῆκος μεν εκατερον πηχεων ἑκατον, ουρος δε οκτω πηχεων." — Herod. ii. 3.

† "Primus omnium id instituit Mitres, qui in Solis urbe regnabat, somnio jussus, et hoc ipsum inscriptum est in eo." — Pliny, xxxvi. 8.

‡ "Non autem, ut nunc literarum numerus præstitutus et facilis exprimit quidquid humana mens concipere potest, ita prisci quoque scriptitarunt Ægyptii, sed singulæ litteræ singulis nominibus serviebant et verbis; nonnunquam significabant integros sensus." — Am. Marcell. xvii. 4.

inscriptions upon them are Egyptian letters,* a statement confirmed to a great extent by the labours of Young, Champollion, and the more recent Egyptologists. Pliny could scarcely be misinformed on this point, as hieroglyphics continued to be cut even after his time, although his assertion does not appear to have been regarded as so important as it ought, or to have been explained away by his different statement in the next chapter, that the two brought to Rome by Augustus had engraven upon them the interpretation of nature according to the Egyptian philosophy†— an assertion which probably afterwards served as the basis of the fanciful interpretations of Kircher.

In Ammianus Marcellinus, we have a translation furnished to him by Hermapion, of the inscription on the obelisk now at San Giovanni in Laterano, and it deserves notice, in so far that it seems to correspond very much with recent interpretations, except that the Grecianizing and Latinizing of the proper names, both of gods and men, makes it difficult to identify them with the Egyptian originals. Instead of a series of philosophical doctrines, the translation of Hermapion attributes the erection of it to Ramses, and gives from the south and part of the east side a brief narration of the principal events of his reign; and when modern scholars have corrected the names, it will probably turn out to be tolerably correct. A single sentence from it may be interesting. The third section on the south side, as originally placed, is as follows — "Apollo, the powerful and most brilliant son of the sun, whom the sun placed above others, and the powerful

* "Etenim sculpturæ illæ effigiesque quas videmus Egyptiæ sunt literæ." — Plin. Hist. Nat. xxxvi. 8.

† "Inscripti ambo rerum naturæ interpretationem Egyptiorum opera philosophiæ continent." — Plin. Hist. Nat. xxxvi. 9.

Mars endowed with gifts, whose benefits endure to all time, whom Ammon loves, who filled the temple with Phœnician spoil, to whom the gods gave life, Apollo the powerful, son of Heron, king of the world, *Rhamestes* who preserved Egypt, subduing the foreigner, whom the sun loves, to whom the gods have granted long life, lord of the earth, Rhamestes the immortal."

In the above, Ramses is evidently described in the first part by the name of Apollo, and in the latter by his own, and an oval containing the name of Ramses occurs frequently upon the obelisk. The other parts of the inscription are in similar style, and those present who have read any recent works on Egypt, will at once notice the general resemblance to the style of the modern translations.

Cassiodorus, on the other hand asserts, that the hieroglyphics expressed the religious doctrines of the ancients in Chaldaic signs in place of letters.*

The knowledge of hieroglyphics as a language wholly perished in the middle ages. The first attempts at revival, such as those of Horapollo and Kircher, were simply ludicrous. But the true key has at length been discovered, and every year is now adding to the value and interest of these beautiful remains, by gradually revealing to us with increasing certainty the precious fragments of ancient history engraven upon them.

The only information we have of the expense of obelisks is from Pliny, who mentions, that for cutting out six, the engineer (artifex) received fifty talents. But whether this was his own fee, or the entire expense, it is difficult to

* "Sacra priscorum Chaldaicis signis quasi literis indicari." — Cassiodorus Variarum, Lib. iii. c. 51.

tell;* probably the former, as we suspect that the *workmen* were furnished by the sovereign and received no wages.

Obelisks were erected by the Egyptians in pairs, one on each side of the entrance to a temple, a tomb, or a pyramid. A solitary obelisk seems to have been unknown to them. They were strictly biographical monuments, the hieroglyphic inscriptions recording the name, the family, and the titles of the person in whose honour they were placed, and who was usually the builder or rather excavator of some adjoining temple or tomb; and of course to remove them from their original sites, at once deprived them of much of their value; and it was yet worse to separate them and carry one to Rome and another to Constantinople, there to tell a wholly erroneous tale to any one able to read the inscribed history.

When Augustus conquered Egypt, and reduced it to the state of a Roman province, he of course became absolute master of all its monuments, and in the true Roman spirit, he immediately resolved to remove at least two obelisks to Rome, and his successors followed his example from time to time, till we read that there were in all forty-eight set up in Rome, viz. — six of the largest size and forty-two small.†

Of these twelve, six are undoubted genuine Pharaonic obelisks, and on all of them the oval containing the name of Ramses the Great occurs. During his long reign of nearly seventy years, many of the most important monu-

* "Et artificem donatum talentis quinquaginta." — Plin. Hist. Nat. xxxvi. 9.

† "Obelisci magni sex, duo in circo maximo, major pedum 132, minor pedum 88½, unus in Vaticano pedum 72, duo in Mausoleo Augusti pares, singuli pedum 42½, obelisci parvi 42; in plerisque sunt notæ Egyptiorum." — Pub. Victor de Regionibus U. Romæ.

ments of Egypt were executed; and of the twenty-three obelisks now known to exist, besides those of Rome, no less than fifteen bear his name. The other six we believe to be of modern date, that is, made in Egypt for Roman emperors. Some of these are plain, and others bear in hieroglyphic characters the names of the emperors for whom they were prepared.

Probably the best mode of bringing the various Obelisks under the farther notice of the Institute, will be to describe them in the order of their size. We have thus to commence with by far the finest and in every respect the most important.

I. The Obelisk of San Giovanni in Laterano. It was brought to Rome by the Emperor Constantius, and set up by him on the Spina of the Circus Maximus, A. D. 357, U. C. 1109.* It was found amid the ruins of the circus, broken into three pieces; dug up by order of Pope Sextus V.; removed to its present site and re-erected by the celebrated architect Fontana in 1588. The lower end had been so much injured that it was found necessary to cut off about two feet and a half.

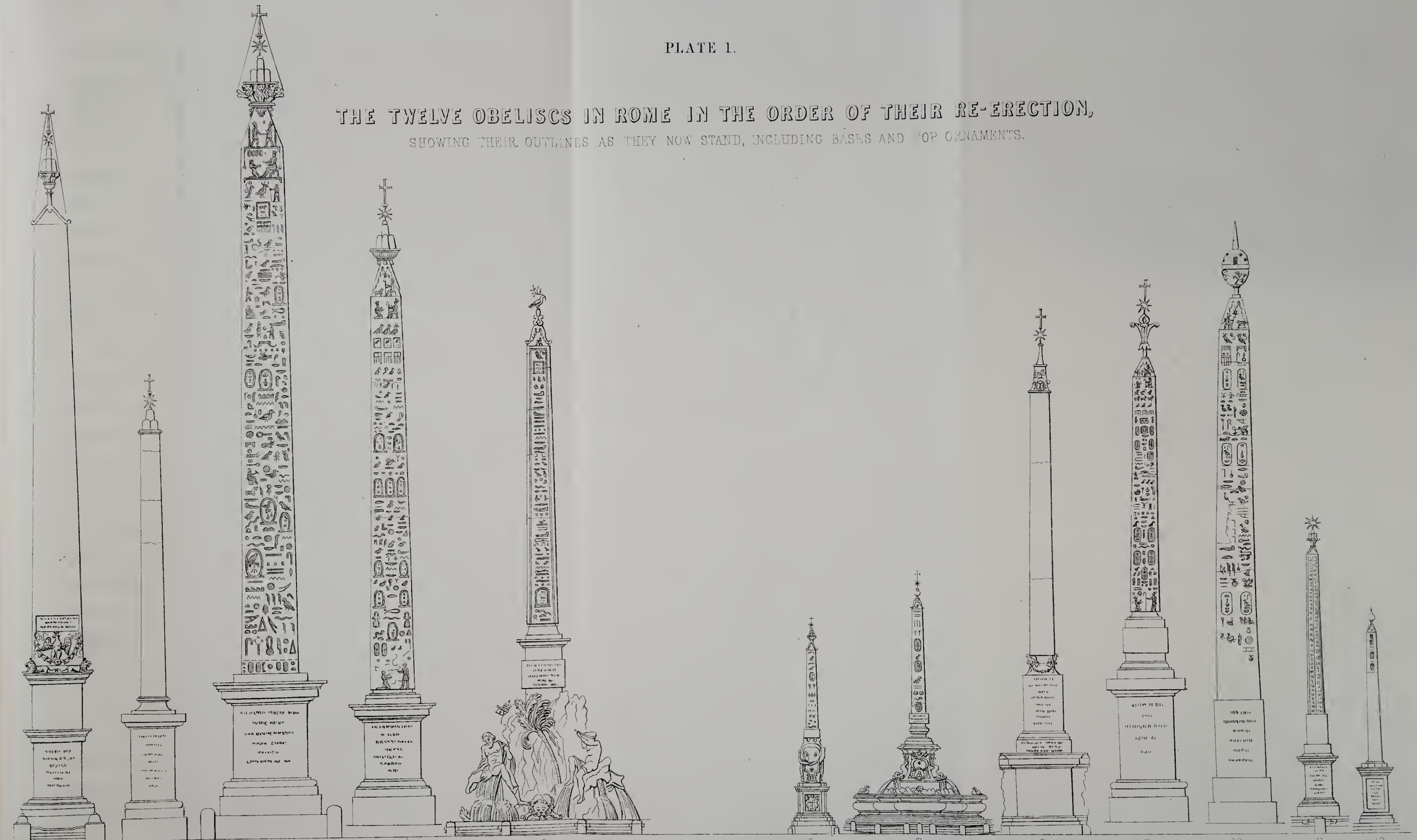
This noble relic of ancient times is now 144 Roman palms in height; or reckoning the palm at $8\frac{1}{2}$ English inches, 102 feet. Each side of the shaft at the base is 9 feet 4 inches; the shaft itself is 91 feet long, and it gradually diminishes in width to 6 feet 4 inches, on the side at the commencement of the pyramidion, and the perpendicular height of the latter is 10 feet 11 inches. The total height, including the base of red granite and the metal work at the top, is $204\frac{1}{2}$ palms or 145 feet.

* Am. Marcellinus, xvii. 4.

PLATE I.

THE TWELVE OBELISCS IN ROME IN THE ORDER OF THEIR RE-ERECTION,

SHOWING THEIR OUTLINES AS THEY NOW STAND, INCLUDING BASES AND TOP ORNAMENTS.



1. VATICAN — Sixtus V — 1586 — 127ft 6
2. ESQUILINE. — Sixtus V — 1587. — 82ft 3
3. LATERAN. — Sixtus V. — 1588. — 145ft.
4. FLAMINIAN — Sixtus V — 1589. — 115ft 6.
5. PAMPHILIAN — Innocent X. — 1651 — 25ft 6
6. MINERVA — Alexander VII. — 1667. — 38ft 3.
7. MACUTEO. — Clement XI — 1711. — 48ft 6.
8. QUIRINAL. — Pius VI. — 1786. — 91ft 6
9. SALLUSTIAN. — Pius VI — 1789. — 36ft 6.
10. CAMPENSE — Pius VI. — 1792 — 103ft 6
11. AURELIAN — Pius VII — 1822 — 53ft 9
12. MATTEI. — Godoy — 1817 — 34ft

The weight of the obelisk itself is 1,310,494 Roman pounds, and calculating the Roman to be ·747 of the English pound, it weighs 978,939 imperial pounds, or 437 tons.

The whole four sides are covered with hieroglyphic inscriptions, cut in the purest style of old Egyptian art, and the effect of the structure is most imposing—in bright sunshine even dazzling. It is probably the obelisk which was spared by Cambyses, as already noticed,* and it is certainly one of those executed for Ramses the Great, and therefore about 3500 years have rolled over its head since it was removed from the quarry of Syene.

We have various details regarding it in Pliny and in Ammianus Marcellinus. Pliny tells us it was made by 20,000 men; but unfortunately he does not inform us how long they were engaged in the work. He also states, that it was erected during the reign of that Ramses who sat on the throne of Egypt during the Trojan war.†

The king had great fear that the machinery employed for erecting it would prove insufficient for the purpose; and to enforce in the strongest manner his anxiety on the subject, he bound his own son to the summit, that care for the safety of the young prince might ensure the safety of the monument—a singular use to make of a royal heir apparent—to employ him as a guarantee for the safety of a mass of granite.‡

It is rather remarkable, that no ancient author gives us any information as to the mechanical contrivances adopted by the Egyptians to move along the ground and raise up the great masses of rock which they employed. The obelisks are mere trifles in comparison with some of them. The two

* Pliny, Hist. Nat. xxxvi. 9. † Ibid. xxxvi. 8. ‡ Ibid. xxxvi. 9.

colossal statues of Amenoph III. (Memnon) contain each 11,500 cubic feet, or about 1200 tons, cut from a rock several days' journey distant; and the Ramses II. at Thebes, when entire, weighed 880 tons, and was transported from Assouan, a distance of 138 miles.

Herodotus describes a monolith at Sais, transported from Elephantine by Amasis. Two thousand boatmen, he says, were employed to bring it, and were occupied three years in the arduous task. He also gives its dimensions very carefully—outside length, 21 cubits (31½ feet); breadth, 14 cubits (21 feet); height, 8 cubits (12 feet). Inside length, 18 cubits, 20 digits (28 feet 3 inches); breadth, 12 cubits (18 feet); and 5 cubits (7½ feet) in height.*

Still more wonderful, however, if true, is the instance of the removal of the monolithic temple of Latona, at Buto, which by Herodotus's account was 60 feet in height, breadth, and depth, and must have weighed somewhere about 5000 tons, even if the walls were only 6 feet thick,† and yet was removed from Elephantine to the Delta, or nearly from one end of Egypt to the other, a distance of about 600 miles.

The largest mass moved in modern times is the boulder which supports the equestrian statue of Peter the Great at St. Petersburgh. It is said to weigh 1200 tons, and was carried only a few miles with extreme labour; and the French found no small difficulty in lately removing the obelisk of Luxor, presented to them by the Pacha of Egypt. They bore willing testimony to the skill of the ancient engineers.

Judging from representations in tombs of the mode of moving other large masses, we may conclude, that the

* Herodotus, II. 175. † Ibid. II. 155.

transport of obelisks was effected by vast numbers of men pulling ropes in concert, while the object to be moved was placed on a sledge, and a person was employed to pour oil or grease in front of the sledge, perhaps on a *tram road* of wood or stone laid for the purpose.

There is an interesting representation of this in the third volume of Sir G. Wilkinson's admirable work,* taken from a grotto at El Bersheh, and another figure, taken from the representation cut in rock of the quarries at El Maasara,† represents a stone drawn by three oxen on a sledge. We may conclude on the whole, that the power of unlimited numbers of men, aided by the sledge, was the principal means employed. The account given by Diodorous Siculus of raising a sloping mound of earth, up which the stones were moved to the height of the intended erection, may have been practised in certain cases, such as the architrave of a doorway, but is wholly impossible in the case of an obelisk.‡ The work of the quarries appears to have been mostly performed by criminals and captives.

We have information from Pliny of the manner in which the Lateran Obelisk was originally conveyed by water down the Nile. He tells us, that a canal was cut from the river to the quarry, and that two flat vessels lashed together, and loaded with stones to the amount of double the weight of the obelisk, were brought under it, the ends resting on the bank of the canal on each side, and that part of the cargo of stones was removed until the boats rose so as to float off with the obelisk. It was then easily conveyed down the Nile to Arsinoe, where it

* Wilkinson, vol. iii. p. 328. † Ibid. iii. p. 324.

‡ Diodorus Siculus, Lib. i. c. 63.

was erected. He adds, that the expense of moving and erecting was far greater than that of quarrying.*

It was, however, a far more arduous undertaking to convey it across the sea to Italy, and of this we have various details in Ammianus Marcellinus. By his account, Constantine the Great was stirred up to undertake the task, by his courtiers reminding him that Augustus had been deterred from attempting it by the difficulty of the undertaking, and also by superstitious scruples, because it had been specially dedicated to the Sun, and fixed immovably in his temple. To this last argument Constantine justly replied, that "he did no injury to religion if he removed a wonder from one temple and again consecrated it in Rome, the temple of the whole world." †

Constantine therefore resolved to undertake the work, and took down the obelisk, which lay long on the ground while the necessary preparations were in progress. At length it was brought to Alexandria, and an enormous vessel, to be propelled by 300 rowers, built to receive it; but ere it was finished Constantine died, and his son and successor completed the work. It is doubtful whether Constantine destined it to ornament Constantinople or Rome, but his son Constantius conveyed it to Rome. It was placed

* "——— perducta usque ad jacentem obeliscum e Nilo, navesque duas in latitudinem patulas, pedalibus ex eodem lapide ad rationem geminati per duplicem mensuram ponderis oneratas, ita ut subirent obeliscum pendentem extremitatibus suis in ripis utrinque; postea egestis laterculis, allevatas naves accepisse onus statutum."

Plin. Hist. Nat. xxxvi. 9.

† "Verum Constantinus id parvi ducens avulsam hanc molem sedibus suis, nihilque se committere in religionem recte existimans si ablato uno templo miraculum Romæ sacraret, id est in templo totius mundi."—Am. Marcellinus, xvii. 4.

on board the ship prepared for it, and safely brought across the sea and up the Tiber "per maria fluentaque Tibridis velut paventis." It was landed at the Vicus Alexandri, three miles from the city, there placed on *chamulci*, very low-wheeled waggons, and slowly drawn by the Porta Ostiensis and the Piscina publica to the Circus.

Ammianus goes on to say, nothing now remained but to set it up, which appeared hardly practicable; but beams of immense length were erected like a forest of machinery, and these were united by long and strong ropes, so as to veil the sky like an immense web, and the ropes being attached to the obelisk, and worked by thousands of men turning wheels, at length the vast sculptured mass, after long hanging in the air, was placed in safety on the part of the Spina prepared to receive it.*

The vessel which conveyed it was the largest ever seen by the Romans, and after being preserved for some years, was employed by Claudius to form the foundation of the Tower of the Mole at Ostiæ.†

The tower was built very carefully on board the ship, of stone with terra pozzolana for cement, and the vessel

* "Sola post hæc restabat erectio, quæ vix aut ne vix quidem sperabatur posse compleri, erectisque usque periculum altis trabibus, ut machinarum cerneres nemus, innectuntur vasti funes et longi, ad speciem multiplicium liciorum, cælum densitate nimia subtexentes, quibus colligatus mons ipse effigiatus scriptilibus elementis, paullatimque id per arduum inane protentus, hominum millibus multis, tanquam molendinarias rotantibus metas, cavea locatur in media."—Am. Marcell. xvii. 4.

† "Profundo jam salo mole objecta, quam quo stabilius fundaret, navem ante demersit, qua magnus obeliscus ex Ægypto fuerat advectus; congestisque pilis superposuit altissimam turrim in exemplum Alexandrini Phari."—Suet. Vita Claudii, c. 20; also Pliny, Nat. Hist. xxxvi. 9.

was gradually sunk with the tower standing upon it, and is in all probability still there, deeply imbedded in sand and mud—sunk exactly like a modern caisson. Pliny speaks of the wonderful size of the ship, which required 120,000 modii of lentiles for ballast.* If we reekon the modius at 26½ lbs., then this ballast amounted to about 1400 tons. We have no information as to the manner in which the obelisk was plaeed in the vessel, but may presume it was laid along the deek, and this heavy ballast would not be more than enough to seeure safety in a gale of wind. It would be an interesting exeavation to endeavour to recover it at Ostiæ.

In narrating these cireumstances, Pliny shows singular ignorance of the first prineiples of hydrostaties. From the fact of its having been brought up the Tiber in a ship, he gravely draws the conclusion, that this proves that there is as much water in the Tiber as in the Nile!†

This obelisk is admirably placed in a wide open space near the extensive buildings of the Lateran, looking down on the pieturesque ruins of Nero's Aqueduet and the city walls, and yet it somehow looks out of place. It speaks plainly of more ancient days, and of a sunnier clime; it looks like a stranger, and not at home; it possesses the greatest beauty in itself, but it does not harmonize with the ruins around it.

Its seulptures tell us of Ramses, and Sethos, and Thothmes, and the other monarehs of the great XVII. Egyptian dynasty, who had reigned and conquered, and

* "Qua nave nihil admirabilius visum in mari certum est, CXX.M. modium lentis pro saburra ei fuere."—Plin. Nat. Hist. xvi. 60.

† "Quo experimento palam fuit non minus aquarum huic amni quam Nilo."—Pliny, Nat. Hist. xxxvi. 9.

died long ere the "pious Æneas" sought the Italian shore, and very long ere Romulus ploughed his furrow round the Palatine Hill, and Rome began to be. Its probable age is not less than 1500 or 1600 years before our era, or from 800 to 900 years before the foundation of Rome.

This Obelisk is represented by fig. 3, Plate I., and fig. 1, Plate II.

II. The next Obelisk in order of height is that now standing in front of St. Peter's.

It was brought to Rome from Heliopolis, by order of Caius Caligula,* to ornament his circus, afterwards known by the name of Nero who enlarged and embellished it.

The site of that circus is now occupied by the sacristy of St. Peter's, so that the obelisk stands within a few hundred yards of the spot where it was first erected in Rome.

It is a plain obelisk, having no hieroglyphics upon it; and from this circumstance, we are convinced that it is not an ancient Egyptian work, but cut by order of Caligula in the quarries of Syene.

We are not aware of any trace of an Egyptian sovereign having ever erected an unsculptured obelisk. To do so was wholly at variance with its purpose, which was to tell its tale just as much as a printed history. It is true that Pliny asserts, according to the common reading, that it was cut at Syene by Nuncorcus, the son of Sesostris, and dedicated to the Sun in obedience to an oracle, after his recovery from blindness;† but the whole passage is manifestly corrupt, and modern critics make the statement to be, that it was cut after the model, and of the same dimensions with that of the son of Sesostris.

* Pliny, Hist. Nat. xxxvi. 11.

† Ibid. xxxvi. 10.

He also states, that it is the only one which was broken by the ancients before it was set up.* If this be the case, then the broken part must have been removed before it was brought to Rome, for the block as it now stands is entire.

The length of the shaft is 80 feet 9 inches, the width at the base is 8 feet 4 inches, contracting to 5 feet 8 inches at the pyramidion — including base and top ornaments the entire height is 127 feet 6 inches.

It was dedicated by Caligula to the memory of Augustus and Titus, and the following inscription still remains —

DIVO CÆSARI. DIVI. IVLII
F. AVGVSTI. CÆSARI. DIVI
AVGVSTI. F. AVGVSTO
SACRVM

This is the first obelisk which was re-erected in modern times. We owe no less than four of them to the indomitable resolution of the energetic pontiff, Sextus V., and the mechanical skill of his very talented architect, Fontana.

This obelisk was disinterred and set up in 1586, and the success of the experiment encouraged the Pope to proceed in the erection of others. Probably he was induced to try this first, because he had only to remove it a few hundred yards.

Although this operation is comparatively recent, the accounts given of it are so conflicting, that it is quite as difficult to reconcile them as to correct the text of Pliny's description of it.

The first doubt is, whether it was thrown down by Totila, as reported by Platina in his life of Sextus V., or

* Pliny, Hist. Nat. xxxvi. 11.

continued to stand erect, as implied by others, who describe the labour and difficulty of raising it from the deep accumulation of earth in which it stood, by means of 60 cranes, worked by 140 horses and 600 men. After it was extracted, four months were spent in moving it 300 yards.

The great difficulty was to re-erect the ponderous mass, for Fontana calculated its weight at 993,537 Roman pounds, equal to 741,151 imperial pounds, or 331 tons; but the genius of the architect triumphed over every obstacle.

By means of a multitude of blocks and tackles worked by a vast number of men, it was at last raised and placed. But the architect is said to have nearly failed at the last moment, by the ropes having stretched more than he calculated, and that the operation succeeded only in consequence of an English sailor, who chanced to be present, shouting out, "Wet the ropes," which was instantly done with the needed result. Another tradition attributes the useful advice not to an English sailor, but to an Italian of the Bresca family of San Remo.* Sextus V. was so anxious for the success of the undertaking, that he had issued an edict, forbidding any one to speak above a whisper during its progress under pain of death, and no one who knew the Pope could doubt that he would without hesitation fulfil his threat.

It is probable that the merit belongs to the Italian, for on being brought before Sextus V., the culprit was desired to name his reward instead of suffering punishment, and he selected the privilege of supplying palm branches to the Sistine Chapel during Easter week, a right which his descendants still claim, whatever may have been its origin.

* See Cancellieri Settemana Santa, p. 196.

An old cotemporary picture, preserved in the Vatican Library, represents the scizure of the man by the guards;* and whether it were the Englishman or the Italian, it is an example of the value of that moral courage which breaks through stringent regulations on a sufficient emergency.

Full details of the machinery employcd are given in a work by Fontana. The expense amounted to 40,000 scudi, or £9000, and the architect was paid by a gift of all the timber, ropes, and iron employed, worth £4500.†

There is another tradition connected with this obelisk, which, if true, would prove great mechanical skill on the part of Buzeta, the architect who set it up for Caligula. A respectable writer, Morelli, a few years ago, discovered a curious manuscript by Giovanni Dondi, a Genoese physician of considerable celebrity, in the latter part of the fourteenth century, who states, that he had himself read the following lines engraven about the middle of it —

> "Ingenio, Buzeta, tuo, bis quinque puellæ,
> Appositis manibus, hanc erexere columnam." ‡

We cannot regard this as impossible, but it must have required a most skilful adaptation of mechanical powers to enable ten fair ladics to raise, by the application of their hands, three hundred and thirty tons of granite from a horizontal to a vertical position.

Unfortunately for the story, not a trace of such inscription is now to be seen, though a telescope has been uscd in searching for it. It has been suggested, that it may have been only painted, and effaced by centurics of exposure, or when set up by Sextus V.

* See Burton's "Rome," p. 236. † Ibid. p. 235.

‡ Cipriani, p. 14.

These details may perhaps seem scarcely worthy of record, but they are excellent examples of the difficulties which beset the inquirer after truth in connection with antiquities in Rome.

This obelisk is now placed in the centre of the Piazza Vaticana, and in most directions is well seen, but when looking towards the church, the effect is wholly lost, as it then falls upon the front of St. Peter's, and might almost pass unnoticed betwixt its rivals, the two well-known and beautiful fountains. It is represented by figure 1 of Plate I. and by figure 2 of Plate II. It serves as the gnomon of a gigantic dial, traced in white lines in the pavement of the Piazza.

It has been remarked, that it does not stand exactly opposite to the great entrance of the church, but 11 feet to the south. It was placed before the front of the latter, was finished by Maderno (under Paul V.), and he deviated greatly in many things from the plans prepared by Michel Angelo.*

III. The first Obelisk which was brought to Rome, but the third in height, is that now named the Flaminian, well known to all travellers who arrive from the north as the first object which is seen on entering the Porta del Popolo— the first ancient monument which meets their eager gaze.

It stood originally at Heliopolis, and was brought over by Augustus as a trophy and a memorial of his conquest of Egypt, and it was dedicated by him to the Sun, as is shown by the inscription still remaining on the base —

* Burton, p. 236.

IMP. CÆS. DIVI. F.
AVGVSTVS.
PONTIFEX. MAXIMVS.
IMP. XII. COS. XI. TRIB. POT. XIV.
ÆGYPTO. IN. POTESTATEM.
POPVLI ROMANI REDACTA
SOLI DONVM DEDIT.

It was employed by Augustus as an ornament on the Spina of the Circus Maximus, and it is asserted that it had fallen down and been broken in pieces before the time of Claudius, who erected the great Lateran obelisk in the same circus. There is, however, no reason why there should not be more than one obelisk on one Spina. There was ample room on that of the Circus Maximus; and, moreover, it is very unlikely that if the first had fallen so early, its fragments would have been interred carefully on the spot where they were found more than a thousand years after. They could not have been left lying as they fell, for they would have effectually blocked up the circus and prevented its being used; and, moreover, the fragments were too valuable to be thus treated.

The vessel in which it was brought was considered so wonderful, that it was dedicated by Augustus, *miraculi gratia*, to the Navalia or dockyard at Puteoli,* where it was afterwards accidentally burned.

The obelisk was discovered among the ruins of the Circus Maximus, lying at a depth of 24 feet below the surface, and broken into three pieces.

It was taken up, removed, and re-erected by the architect Fontana, by order of Sextus V. in 1589. It was found

* Pliny, Hist. Nat. xxxvi. 6, 9.

necessary to cut off about 2 feet of the lower end which had been irreparably injured.

The present length of the shaft is 107 palms or 75 feet, and its width at the base is $10\frac{3}{4}$ palms or $7\frac{1}{2}$ feet.

The height of the whole as it stands, from the ground to the summit of the cross, is 163 palms or 115 feet 6 inches.

This obelisk is now admirably placed. Besides its effect on entering the Porta del Popolo, already noticed, the piazza is sufficiently spacious to give it good effect, and it forms a striking vista from the three diverging streets, the Corso, the Babuino, and the Ripetta.

It is covered on all the four sides with hieroglyphics of pure ancient Egyptian workmanship, and from these we learn, that it was erected by Sethos I., before the temple of Re Athom at Heliopolis.

The obelisk bears also the name of Ramses, in whose reign it appears to have been cut in the quarry, and partly engraved, so that it must have been executed during the latter part of the abode of the Israelites in Egypt.

A recent writer on Egypt has pointed out, that the distinctive title in some of the ovals of this obelisk has been effaced, and that this is the title of Sethos. It seems to be now tolerably ascertained, that Sethos II. was the Pharaoh who was drowned in the Red Sea, and who brought upon his country the heaviest calamities it had ever experienced, and that in consequence of this his own proper monuments or memorials, especially his tomb, were left unfinished. He was an object of utter abhorrence to the Egyptians, and in token of this, his name was effaced wherever it occurred, and not only so, but that of his great grandfather who bore the same name, viz.—

Sethos I. was occasionally treated with the same deep indignation. Instances of this are given in Egypt, and this Obelisk is noticed as another.* The story adds greatly to our interest in the monument, and Egyptian literature has made such progress of late years, that we are entitled to regard the results which it communicates as something more than conjecture, and ere long we doubt not it will assume the connected form of history, based upon cotemporary documents, requiring only to be purged from the additions of national and personal vanity, or the distortions communicated by the jealousies of rival races and families.

We cannot, then, assign to this monument less age than about 1500 B. C., or 3355 years from the present year.

The figure No. 4 of Plate I. represents this Obelisk, and also figure 3 of Plate II.

IV. The fourth Obelisk, that of the Monte Citorio or Campense, from being placed in the Campus Martius, was also brought to Rome by Augustus, who employed it as the gnomon of his celebrated dial.

It has been regarded as the most ancient and best sculptured of all those in Rome. The fine execution of its hieroglyphics was particularly noticed by Winkelman, but unfortunately it is greatly injured. It was found under the cellars of a house at no great distance from where it now stands, broken into five pieces, besides being otherwise damaged, and a portion of the hieroglyphics defaced.

It had been long known to exist, but Sextus V. probably thought it unworthy of his labour, and it was not

* See Israel in Egypt. p. 417.

disinterred till 1748, and it was not till 1792 that it was repaired and set up by Pius VI.

As it now stands, the total height is 152 palms or 103 feet 6 inches, and the obelisk proper is 97½ palms or 69 feet, the width at the bottom is nearly 11 palms or 7 feet 10 inches.

In order to repair it and other obelisks, use was made of a noble column of the same red granite of Syene which formerly stood on the spot, erected by M. Aurelius in honour of Antoninus Pius, but which had been so much injured as to give some excuse for thus employing it.

The Monte Citorio is a slight elevation above the general level of the Campus Martius, believed to be formed by the ruins of the amphitheatre of Statilius Taurus, built in A. U. C. 724, but the base of the obelisk occupies the exact spot on which stood the base of the Antonine Pillar, now in the Vatican Garden, to which it was removed in 1789.

Part of the lines of the sun-dial to which this obelisk belonged were brought to light in digging the foundations of the Sacristy of San Lorenzo in Lucina, in 1463.

We have various notices of this obelisk in Pliny. He states, that it was cut by Sesostris, and the ovals of Ramses and other early Pharaohs occur upon it.

Pliny also mentions particularly the dial, or as some think it, the meridian line which was applied to it, and which appears to have been regarded as something very wonderful.*

* "Ei qui est in campo Divus Augustus addidit mirabilem usum ad deprehendendas solis umbras, dierumque ac noctium magnitudines, strato lapide, ad obelisci magnitudinem," &c., &c.—Plin. Hist. Nat. xxxvi. 10.

He goes on to notice, that the mathematician Manlius, added a golden ball to the summit, but the passage is evidently corrupt and unintelligible; and he adds, that after about thirty years it ceased to be correct, whether by changes in the sun's course, or changes of the heavens, or of the earth's centre, as he understood had been noticed in other places, or by the tremors of the city, or by the floods of the Tiber depositing mud, is uncertain.

It is obvious from this passage, that Pliny was no mathematician, nor does dialling, or any other branch of that science, ever appear to have flourished in Rome.

A dial was brought from Catania by Valerius Messala in the year B.C. 261, and set up in the Forum at a distance of five degrees from the place for which it was calculated; and one found at Pompeii was made for the latitude of Memphis; and Plautus, in a fragment preserved by Aulus Gellius,* makes one of his characters most heartily anathematize the invention of dials.

It has been thus translated—

> "The gods confound the man who first found out
> How to distinguish hours! confound him, too,
> Who in this place set up a sun-dial
> To cut and hack my days so wretchedly
> Into small portions. When I was a boy
> My belly was my sun-dial; one more sure,
> Truer, and more exact than any of them.
> This dial told me when 'twas proper time
> To go to dinner, when I had ought to eat.
> But now-a-days why, even when I have,
> I can't fall to, unless the sun give leave."
>
> *(Thornton's translation of Plautus.)*

Figures 10, Plate I. and 4, Plate II. represent this Obelisk.

* Noctes Atticæ, Lib. iii. c. 3.

V. The fifth Obelisk in height is that which stands in the Piazza Navona, known as the Pamphilian, or the Obelisco Agonale, from being now placed where was formerly the Circus Agonalis, whose form and boundaries are indicated by the houses of the present Piazza Navona.

It was cut out and engraved at Syene in honour of the Emperor Domitian, and employed by Romolus to adorn his circus on the Appian Way. There it was found broken into many pieces, and the five largest fragments were removed, repaired, and set up by Innocent X. under the care of Bernini in 1651.

The shaft is now 74 palms or $52\frac{1}{2}$ feet long, and including the base and top ornaments, 135 palms or $95\frac{1}{2}$ feet, and it measures 8 palms or 5 feet 4 inches on the side at the base.

The whole style and execution is so inferior, that the tasteful eye of Winkelman long ago detected the fact of its being an imitation, although there was not then sufficient knowledge of hieroglyphics to confirm his opinion.

Dr. Thomas Young pointed out the comparatively modern execution of the hieroglyphics; and by means of his and Champollion's phonetic alphabets, the name of Domitian is easily read upon it, and also the title of Emperor.

It furnishes us with a curious illustration of the utter puerility of the speculations of the celebrated father Kircher, who published six great folios in 1636, in which he professed to explain and translate the whole hieroglyphic inscriptions of the obelisks.

The oval, in which is inscribed, in hieroglyphic characters, the name, Καισαρος Τομιτιανος Σεβαζος (Cæsar Domitianus Augustus), and nothing more, is translated thus by Kircher —

"The beneficent Being who presides over reproduction, who enjoys heavenly dominion and fourfold power, commits the atmosphere by means of Mophtha, the beneficent principle of atmospheric humidity, unto Ammon, most powerful over the lower parts of the world, who by means of an image and appropriate ceremonies, is drawn to the exercising of his power."

The oval containing the title Emperor, Αυτοκρατωρ, is thus rendered—"The author of fecundity and of all vegetation is Osiris, of which the reproductive faculty is drawn from heaven into his kingdom by the Saint Mophtha."

The work of the learned Jesuit has been very justly characterized as one of the most astounding efforts of imagination the world has ever seen.

This obelisk, in other respects so inferior to the rest, is thus of considerable interest in the history of hieroglyphic discovery. Plate I. figure 5, and Plate II. fig. 5, give a representation of it, and Plate III. shows the two ovals which contain the name of Domitian.

VI. and VII. The Esquiline and Quirinal Obelisks.

These two were orginally placed in correct Egyptian taste, one on each side of the entrance to the Mausoleum of Augustus. They were brought to Rome for this purpose by Claudius, A. D. 57.

One of them was removed to the Piazza of Sancta Maria Maggiore on the Esquiline Hill, by Sextus V. in 1587, and the other, two hundred years after by Pius VI. in 1786, to the Quirinal Hill, where it stands betwixt the two well-known groups of men and horses.

The former was broken into five pieces, and it is said to have been used for various experiments by Fontana,

before he attempted the erection of the Vatican Obelisk, although the inscription on the base makes its erection a year later.

These two had no pyramidion, the length of each is about 66 palms or 46 feet 9 inches, which is nearly doubled by the modern bases and the ornaments on the top.

The width of the side is 4 feet 3 inches.

Both these obelisks are plain, and for the reasons already given, this is a proof that they are not ancient, but cut out for Claudius at Syene.

The fractures are very visible, owing to their want of hieroglyphics, and the three lines across the Esquiline, and the two across the Quirinal, detract greatly from their beauty, as will be seen on looking at Plate I. fig. 2. See also Plate II. figs. 6 and 7.

VIII. The eighth Obelisk stands on the Trinita dei Monti, to which it was transported by Pius VI. in 1789, from its original situation on the Spina of the Circus of Sallust in his gardens, though of much later date than the age of the historian.

It is $62\frac{1}{4}$ palms or 44 feet high, and with base and ornaments $136\frac{1}{4}$ palms or $96\frac{1}{2}$ feet, and the side is $6\frac{1}{4}$ palms or 4 feet 6 inches, and it was found broken into two pieces.

It is entirely covered with hieroglyphics but of very rude workmanship.

Champollion read* in the ovals the names of Hadrian, his wife Sabrina, and his favourite Antinous, who having died in Egypt, was added to the number of Egyptian

* Champollion, Systeme Hierogl., i. 42, 43.

divinities. We may therefore conclude, that it was cut by order of Hadrian in honour of his lamented favourite, and possibly first erected in Egypt. There is no record of when or by whom it was brought to Rome; if Hadrian had imported it, he would probably have placed it in his villa at Tivoli; see Plate I. fig. 9, and Plate II. fig. 9.

IX. The Aurelian Obelisk which now ornaments the public walks on the Pincian Hill, derives its name from having been found in three pieces amid the ruins supposed to be those of the Circus of Aurelian (or of Heliogabalus), outside the Walls near Santa Croce in Gerusalemme. This obelisk was removed from place to place, but finally by Pius VII. to the Pincian Hill in 1822.

Its length is $41\frac{1}{2}$ palms or 29 feet 9 inches, and its width 2 feet 2 inches. The whole present erection is 53 feet 9 inches or $77\frac{1}{4}$ palms.

It is covered with hieroglyphics of genuine Egyptian workmanship, as are the three small obelisks which we have still to notice. See Plate I. fig. 11, and Plate II. fig. 9.

X. Macuteo, so named from having been formerly erected in the adjoining piazza, San Macuto, from which it was moved by Clement XI. in 1711 to its present situation in front of the Pantheon.

Its height is only 27 palms or $19\frac{1}{2}$ feet, and the width 2 feet 8 inches, but from ground to summit is 65 palms or $48\frac{1}{2}$ feet. It is covered with beautiful hieroglyphics. See Plate I. fig. 7, and Plate II. fig. 10.

XI. Minervan Obelisk in front of the church of the Minerva, erected by Alexander VII. in 1667. It is $22\frac{1}{2}$ palms or 16 feet high, and 2 feet on the side, and the whole

modern structure is 54 palms or 38 feet 3 inches high. See Plate I. fig. 6, and Plate II. fig. 11.

This and the last were found together, in preparing the foundation of the Convent of the Minerva, and from this circumstance, and from the fact, that the Regionaries name a temple of Isis and Serapis as existing in this locality, it is concluded that they formed part of its ornaments: here, too, was found the Isiac Altar now in the Capitol.

XII. Obelisco Mattei, now in the gardens of the Villa Mattei, belonging to the Prince of Peace. It was erected there by the well-known Godoy in 1817, after having long stood in the Piazetta del Campidoglio. It was given by the Roman Senate in 1582, to the Duke Mattei, a great collector of antiquities. Nothing is known of its early history.

It is very small, being only 12 palms or $8\frac{1}{2}$ feet high, and nearly 2 feet on the side, but it is raised on a block of red granite, cut to suit its size, and with pedestal and ornaments, is in all about 39 feet in height. See Plate I. No. 12, and Plate II. No. 12.

Like the two last, the hieroglyphics are beautifully cut.

Such are the twelve obelisks now standing erect in Rome.

We heartily sympathize with the ancients in their admiration of obelisks; no form is more pleasing, none more graceful, none more durable. It is one which the eye never wearies in contemplating, and the outline of which is perfect, in whatever direction it may be seen. Though it appears slight, it is secure and stable.

Much however of its effect depends on its situation. If placed in a confined space, surrounded by buildings, its beauty is lost. It is seen to best advantage when it has no back ground but the sky.

The Romans have shown great want of taste in their treatment of them; in order to increase their height, they have mounted some of them on pedestals of the most uncongenial forms, and they have hidden the sharp pointed summits of every one of them under hideous masses of brass and bronze, representing insignia of popes, or other subjects equally unsuitable, and the disfigurement is completed by two or four great rods to support the mass of metal.

The injury thus done can hardly be overstated, nor can any reason be imagined for it.

An obelisk ought to spring at once from the earth, or if circumstances require a base, it ought to be of the simplest form, and that this was the Egyptian taste is proved by many sculptured and pictured monuments still remaining.

What can be more absurd than to balance the Minervan Obelisk on the back of an elephant?—fortunately it is one of the smallest; what more out of place, than that in the Piazza Navona, rising up out of a great group of marble foliage, and figures of tritons and nymphs, from among which issue forth the ample streams of a copious fountain, a scene at variance with every idea of Egypt and its arid plains, where gushing fountains are unknown.

The Vatican Obelisk has a base of not very objectionable outline, probably that which was originally prepared for it in Rome.

It is of considerable height, about 21 feet; on the top of this are placed four lions, one at each corner, and the obelisk rests on their backs, each supporting a weight of above 80 tons! the position of the unfortunate animals is ludicrously painful.

This, however, is not a mere modern barbarism: it was introduced in ancient Rome; for when Cladius erected the

great obelisk in the Circus Maximus, he placed a brazen globe, covered with plates of gold upon the apex. This was soon after destroyed by lightning, and its place supplied by the figure of a large torch in gilt brass.*

On the summit of that which stood in the Circus of Romolus was placed a globe or ball, whence rose an arrow point indicating a ray of the sun.†

No doubt the lofty bases and the tall top ornaments increase the absolute height of the erection, but they as certainly injure the true effect of the Obelisk.

The Obelisk has never been employed in this country on a scale of sufficient magnitude to test its suitableness in our cloudy sky and moist atmosphere. Occasionally a small obelisk is found as a monument in a churchyard, and it is always in itself a pleasing object, although it may not harmonize with those around.

Probably the expense may long prevent any one attempting to cut and set up one of 80 or 100 feet in length. Should there be a desire to try the experiment, there are one or two lying half cut in the quarries of Egypt. We fear that neither Cornwall nor Aberdeenshire can furnish masses of sufficient dimensions.

One caution we must give: an imitation obelisk, built of blocks of stone, however well dressed, is a miserable affair; an obelisk must be a monolith, and the only appropriate material is red granite.

Two engravings by Cipriani, 1823, are copied in illustration of this paper.

Plate I. represents the twelve Obelisks in the order of the date of their modern erection, and shows the various

* Am. Marcellinus, xvii. 4.

† Burgess on the Circus on the Appian Way, p. 79.

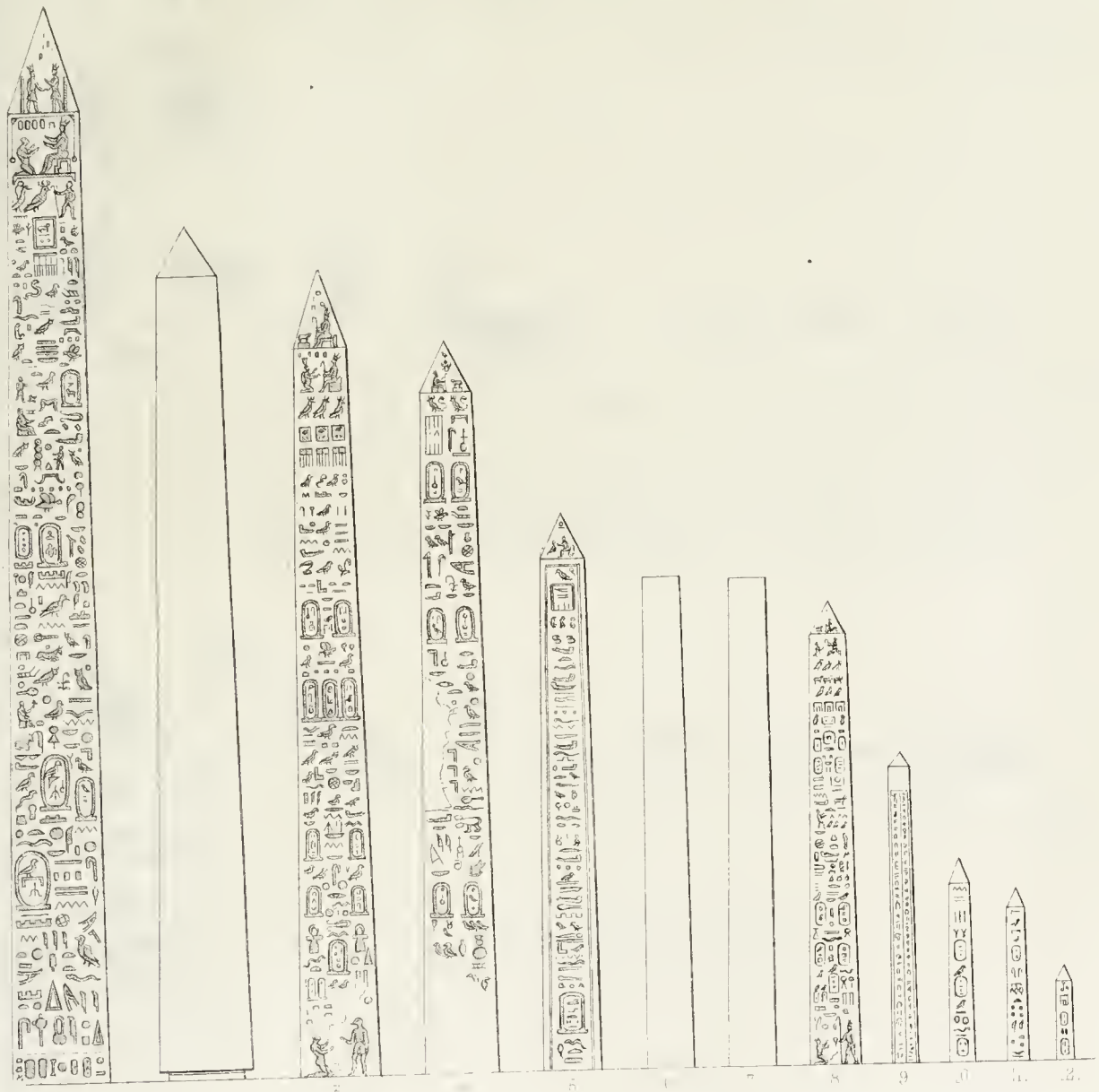
bases on which they stand, as well as the top ornaments which encumber them.

Plate II. shows the relative sizes of the ancient shafts.

Plate III. represents the two ovals on the Pamphilian Obelisk, which contain the name and titles of Domitian, giving the hieroglyphic characters with their phonetic translation.

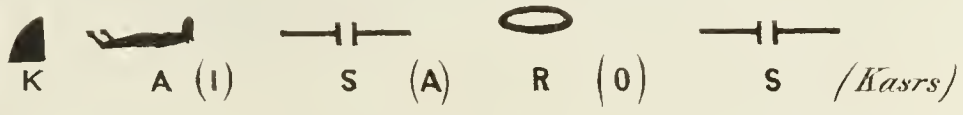
PLATE II.

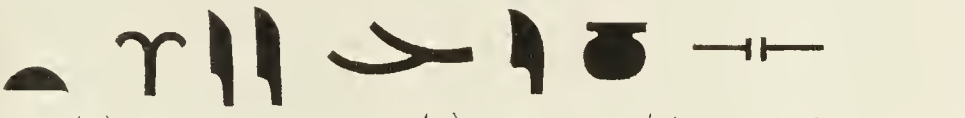
SHAFTS OF OBELISCS IN ROME IN ORDER OF THEIR LENGTH.

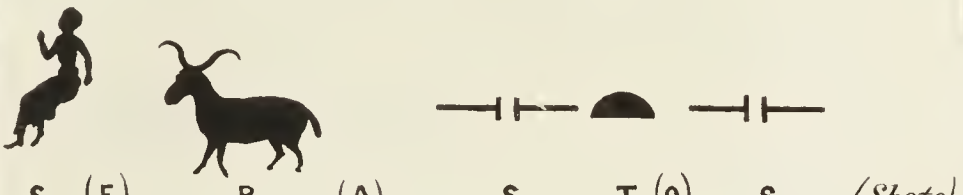


1 Laterani [illegible]
2 Vaticani 83[illegible] 3in
3 Flaminian 6[illegible]
4 Campense [illegible]
5 Pamphilian 52ft 5in
6 Quirinal 46ft 8in
7 Esquilin [illegible] 9in
8 Sallustian 44ft
9 Aurelian 39ft 6in
10 Macuteo [illegible] 6in
11 Mauro[illegible]
12 Mattei [illegible] 3in

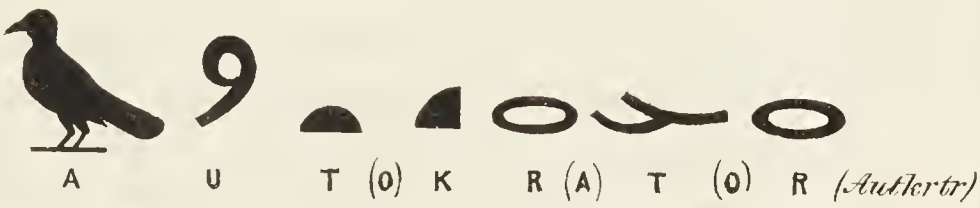
[illegible] are Obelisks Egyptian & Monuments
[illegible] are Roman work







Cæsar Domitianus Augustus.

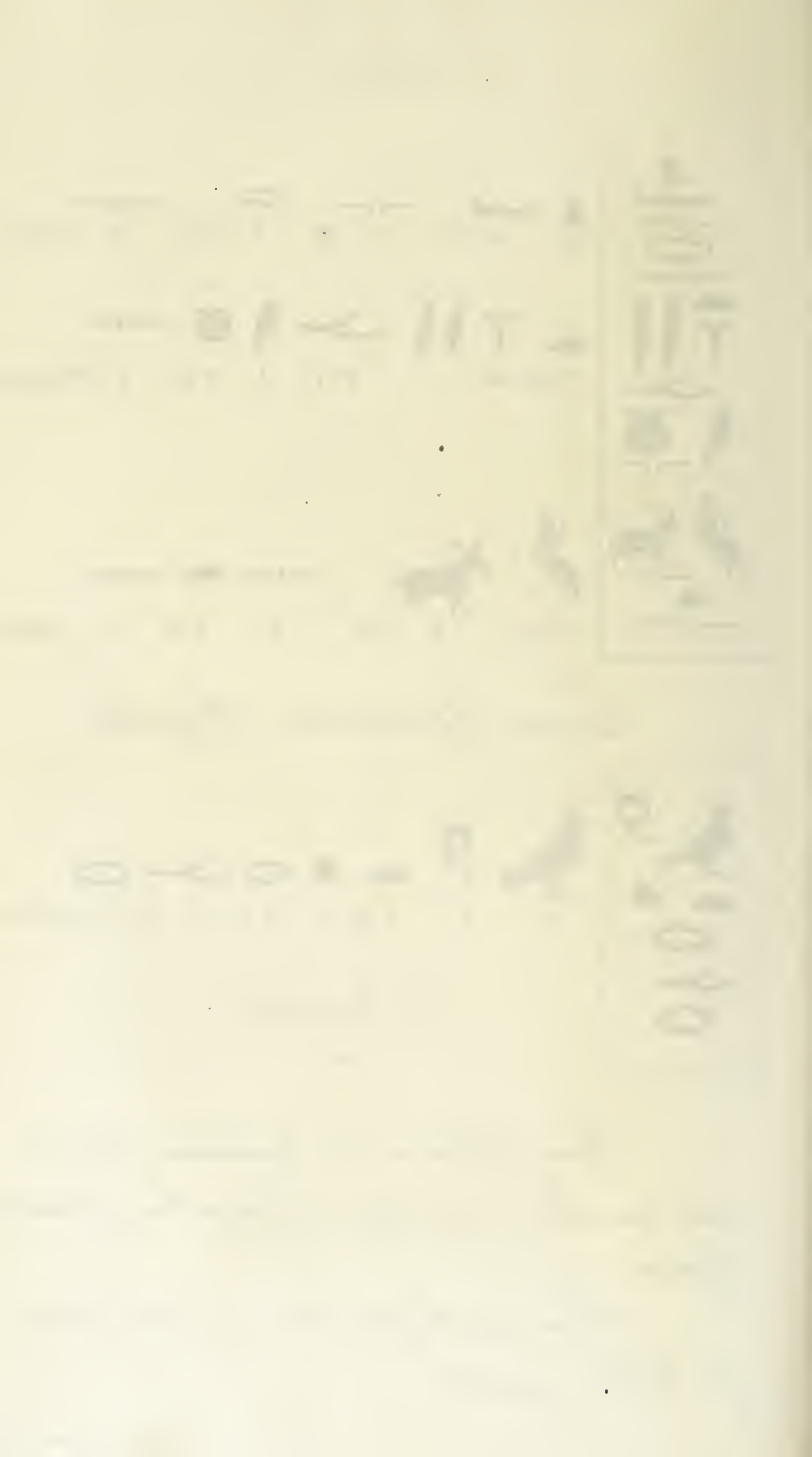


Imperator.

Hieroglyphics on the Pamphilian Obelisk with translations according to Champollions Phonetic System.

These are the two Ovals whose translation by Kircher is quoted.

W. H. LIZARS. LITH.



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No. VII.

ON THE

MONUMENTAL EDIFICES

OF THE

EGYPTIANS.

BY

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[*Read at a Meeting of the Institute in Glasgow, held on 24th March* 1856.]

Wotton, a writer of the seventeenth century, and who was distinguished by his love of architecture and a shrewd appreciation of the beauty of art, has observed, that architecture needs no apology where there are noble men and noble minds.

In an assembly therefore like the present, met for the purpose of hearing something on Egyptian Edifices, it were an idle waste of time to occupy your attention by any prefatory remarks, with the view to enhance a subject already possessing so many claims on the admiration and respect of well cultivated minds.

The theme of this evening's discourse is, on "*The Manners and Customs of the Egyptians, as Illustrated in their Buildings.*" It embraces a period of more than 2000 years before

the Christian era. Its monuments on the shores of the fruitful Nile extend from Alexandria on the Mediterranean to the second cataract in Nubia, a distance from north to south of 1000 miles. It comprehends the wonders Ghizeh, Memphis, and Thebes — the islands of Philœ and Elephanta, and the gigantic excavations of Aboo Simbul and Girsché.

With such ample matter, I pretend only to point out *some* of the leading features — to touch upon *some* of the more prominent workings of man's intelligence in that country and at various epochs. I shall leave to you, in your subsequent leisure, and in your observation of the illustrations which you already possess, to pursue the course of thought which I shall suggest.

All writers on Egypt seem to be agreed, that the earliest specimens of the architecture of this ancient people are to be found in the tombs of that country, and that the character of their temples and other monumental edifices is to be assigned to these types. In fact, there seemed to be a religious veneration for antiquity, which led them to retain the same forms and customs which prevailed in former periods, and from which they would not depart. We shall be safe, therefore, in giving a description of tombs comparatively recent, yet still two or three thousand years old, as they were doubtless identical in arrangement and decoration with those of more ancient times.

Near Thebes is the rocky valley of Biban-El-Molook, which was the necropolis or burial place of the royal family of a certain period; and the famous work of the French on Egypt, and the publications of Champollion Figeac, as also the elaborate descriptions of Belzoni, make us acquainted with these venerable monuments of Egyptian art. At the farther end of the valley is a narrow opening, evidently made by the labour of man, and bearing traces

of Egyptian sculptures. At the foot of the mountains, on the sloping sides, various apertures like doors, are perceptible, mostly blocked up, and the decoration of which is not apparent until you approach quite near. These doors are all alike, and form the entrances to the royal tombs — each tomb has its own doorway, for there was no communication from one to another, as they were all quite distinct, but latterly apertures have been made by parties who were in search of treasures or antiquities.

No order was observed, apparently, in the choice of any particular site; each king seems to have had his tomb excavated wherever he found a stratum of rock suitable to the immense excavation which he was about to make.

The entrance doorway was generally very simple and unadorned, but as soon as the traveller passes the portal, he is surprised, on entering a long gallery, to find all the walls covered with brilliant and elaborate paintings. Here and there are niches recessed in the sides, of various sizes, and a succession of doorways. The floor most frequently is on an inclined plane, falling from the entrance to the further end. Here and there is sometimes a kind of pit, as if to prevent access to forbidden intruders, or to receive a sarcophagus, or to act as a reservoir for the waters to drain into. Occasionally there are flights of steps, and often two or three halls or vestibules, with ceilings of a concave form, and supported by square pillars, covered, as well as the walls, with hieroglyphics. Then come another succession of galleries, and a series of portals leading to the principal hall, called by the Egyptians the Golden Hall, of greater extent than the other, sometimes a plain square chamber, and containing the sarcophagus in the centre, which was frequently hollowed out of some rare or peculiar stone, as the famous alabaster sarcophagus in the Soane

Museum. This is so transparent, that if the room be dark, and a lighted candle be placed in the centre, it presents a brilliant appearance.

Sarcophagi — Sometimes these sarcophagi are of granite or basalt, specimens of which may be seen in the British Museum. They consist of two blocks, the body and the lid, and are covered occasionally inside and out with hieroglyphics, and the lid is carved into the shape of a mummy. Some measure 15 feet long by 6 feet wide and 8 high.

The Golden Hall is frequently decorated with square pillars or columns, which increase the richness of the architectural effect, and the roofs are cut into the form of a flat segment of a circle or depressed pediment. Recesses and square niches are cut into the side walls to receive mummies, and still further, beyond the Royal or Golden Hall, may be other galleries and sepulchral chambers.

Painted Hieroglyphics—The principal objects of admiration in these extraordinary excavations, are the sculptured and painted pictures and hieroglyphics, which cover the walls and frequently the ceilings. The leading subject in one is the Sun, the chief deity of the Egyptians, as the great vivifying principle of nature, both animal and vegetable ; and the hieroglyphics seem to consist of the most refined mysticism and abstruse allusions. He is represented on one side, in a series of pictures, in his course to the meridian, emblematic of the king while alive. On the other, the sun is represented in his course downwards towards the horizon—an image of the king after death. In the hall preceding the golden one, the subject generally treats of the king as appearing before his judges, who are to decide upon the doom of his soul.

We learn, that immediately each king aseended the throne, he commenced the exeavation for his tomb; and thus it frequently oeeurs, that the duration of the reign of the sovereign may be ascertained from the extent of the eatacomb.

Resumé — The form, arrangement, and deeoration of these sepulehres bespeak peeuliar habits and modes of thinking in this remarkable people. The long galleries, whieh seem applieable to no useful purpose, the splendid paintings, whieh were rarely seen, and that only by artifieial light, the eostly nature of the saered deposit, so seldom visited, evinee eertain assoeiations, whieh find no eorrespondenee with the eustoms and usages of modern times. With us, the exterior of the sepulchre attraets attention, but the interior rarely offers embellishments. With the Egyptians, the outside seems to present no unusual appearanee, and an insignifieant door marked the aeeess to the royal eenotaph. But the interior was profuse in every arrangement and deeoration, which eould interest or enchant the beholder; and the king, enshrined in his tomb, was surrounded by the splendour of a living monarch, aeeompanied by his ehiefs and followers, shadowed in the painteds eulpture on the roeky walls. The mummies of his family, his friends and favourites, occupied other parts of the royal eenotaph, and formed so many links in the chain of his affeetions.

Mummies — The mummies of the dead were embalmed and shrouded in a most eareful and sumptuous manner. The parts more immediately perishable were withdrawn, and aromatie spices and ehemical preparations were introdueed, and also applied externally, so as to preserve the body from

decay. The finest linen, in continuous folds, wrapped the limbs round and round. Images of their creature gods, amulets, beads, jewels, and gold and silver ornaments, were profusely distributed over the body. It was then encased in a coffin of precious wood, richly decorated within and without — sometimes a second case was added — and the huge mass deposited in the stone sarcophagus, till the fury of the conqueror, or the curiosity or rapacity of the traveller, dragged it from the silence of the grave, and set at nought the pious reverence of antiquity.

Animal Tombs — These sepulchral excavations were made not only for royal and distinguished personages, but mummies of sacred animals were honoured by a similar importance of funeral deposit. Near Beni Hassan-el-Aamar, on the Nile, is a hill, perforated with galleries and wells, in which is found an incredible quantity of mummies of cats, crocodiles, and some other quadrupeds. Near these is an excavated temple, dedicated to the goddess Pascht (Bubastis), to whom the cat was consecrated as a sacred animal.

Aboo Simbul—Our next step leads to another class of wonderful excavations of this remarkable people. At Aboo Simbul, in Nubia, the lofty banks of the Nile present a rocky rugged aspect. On each side of the valley, and almost facing the Nile, are two splendid elevations.

Front — One has four sitting figures, the other six standing figures of colossal dimensions—these are cut out of the face of the rock. Time had driven the sand, so as to accumulate and cover up the façades to a considerable height. Belzoni, with immense labour, cleared away the sand, and what had hitherto been considered a mere sculp-

tured face in the rock, was now discovered to be the frontispiece to a sumptuous tomb temple, a door being found in the centre of the lower part.

Dimensions — The front of the larger one with the four figures, is 117 feet wide by 86 feet high.

The figures are 64 feet high to the top of the caps. The ears are 3 feet 6 inches high, the face 7 feet, the beard 5 feet 6 inches long. From the shoulder to the elbow 15 feet 6 inches. The height of the door is 20 feet, and from the top of the door to the top of the cornice is 66 feet 6 inches. On the top of the door are colossal figures of Osiris 20 feet high.

On the top of the cornice is a row of monkeys, 8 feet high, 6 feet across the shoulders, and 21 in number.

Interior — Let us now enter the Tomb Temple, and passing the portal, we find a large vestibule or pronads, 57 feet long and 52 feet wide. On each side is a row of four pillars, dividing the vestibule into three aisles or avenues. The height is about 30 feet, the pillars are 5 feet 6 inches square, and in front of each is a colossal standing figure, with crossed arms, and holding in their hands a crook and a whip. The walls, pillars, and ceilings, are covered with hieroglyphics.

There are thirteen other chambers. A passage leads into a smaller chamber with four square pillars, and on the walls are representations of battle pieces.

The Sanctuary is 23 feet 6 inches long and 12 feet wide. In the centre is a pedestal, and in a niche at the end four colossal figures, the presiding divinities of this solemn cavern, hideous in their features, and fantastically coloured with various hues. Heeren supposes that a sarcophagus once stood on the pedestal before the statues, and that we ought to consider this rather as a tomb than a temple.

The greatest width of the excavation is 149 feet, the greatest depth 196 feet 4 inches. The name of Rameses appears on every part. He was probably the Sesostris of Herodotus, and the Sesoosis of Diodorus. This seems to have been his tomb, afterwards converted into a temple.

Girsché.—The next modification in advance appears in the Temple of Girsché, the oldest parts of which are doubtless those cut in the rock, which probably was simply a tomb; but being subsequently required and appropriated to the purpose of a temple, a fore court and propylon, or large outer gateway, was then attached.

Having considered the original type of Egyptian Architecture, as existing in the tombs of that extraordinary people in the valley near Thebes, and having described the Rock Temple at Aboo Simbul, and the Temple at Girsché, which is partly cut out of the rock, and partly constructed beyond the face of the rock, we shall now proceed to examine the form, arrangement, and parts of one of their great temples, such as those we find at Thebes.

Sphinxes.

The temples were generally situate on or near the banks of the Nile; or, where placed at any distance from the river, were connected with it by an ample avenue or causeway, which led up to the sacred edifice. This was called a Dromos, and was frequently lined on each side by sphinxes. These are conventional figures, composed of the couchant body of a lion, with the head of a man or female, or a ram surmounted by the high cap. Sometimes, instead of the fore-paws being those of a lion, they are human hands and arms; the two hind legs are now and

then those of a goat. The drawing before us shows one of the sphinxes at Siboa; it has a man's head surmounted by the high cap, the hair is gathered behind into a tail; there is the serpent over the forehead, and the beard under the chin, and the animal rests on a plinth. The figures are 11 feet long and 18 feet apart. At Carnak, the avenue consists of sphinxes with the ram's head, surmounted by the cap of dignity; there is a kind of mummy figure standing erect between the fore legs and immediately under the chin.

These sphinxes were carved out of stone, and were painted, the face being red, and the mane with alternate stripes of yellow, blue, and red. This Dromos at Carnak was 63 feet wide, the sphinxes about 18 feet long and 12 feet apart. Now, the avenue was about 6200 feet, or nearly $1\frac{1}{4}$ mile long, consequently there must have been above 200 sphinxes to line the way on each side. But they are not all of the same character, and vary in the heads and extremities. The larger sphinxes were carved out of sandstone or limestone; but some have been found of granite and basalt; and at Heliopolis are ruins of a sphinx of bright sparkling yellow marble 22 feet long. At Siboa, the extremity of the avenue, next the river, has two sphinxes grouped with two upright standing figures, which look remarkably well. But the most extraordinary of the sphinxes in Egypt, is the one which stands on the same plateau as the Pyramids of Ghizeh, supposed by Belzoni to be of equal antiquity with it. The head and neck alone rise above the sand of the desert, in which the rest of the body still lies buried. Various travellers have at times cleared some of the parts from the sand. It has the usual lion's body with the head of a man. The whole length of the figure was 143 feet, the circumference round the forehead 102 feet, from the chin to the top of the head about 28

feet. The body is cut out of the roek, but the fore-paws, whieh are about 50 feet long, were eonstrueted of masonry. The whole was originally eovered with a eoating of plaster, and then painted, first with a general tint of yellow, as usual, and the other parts varied with red and blue. The face and neck had the usual briek-red eolour, eommon to all statues, representing the natural flesh eolour of the Egyptians in all their paintings. Abdallatif, an Arab writer, who wrote a long time ago a deseription of the antiquities of Egypt, saw a large portion of the eolour still remaining, and expresses his admiration of the effeet.

Origin of Sphinxes.

We have no elue to guide us, either in the writings of aneient authors or in Egyptian monuments, so as to enable us to judge of the origin or meaning of these monstrous forms. They are doubtless mixed up with the inexplieable mystieism of the Egyptian worship, and probably were meant to embody some of the peeuliar attributes supposed to be possessed by their ereature gods. The expression of the eountenanee, whether of a ram or the human faee, is always benignant and ealm, indicative of a state of mild repose and dignity.

The Egyptian lion in granite, basalt, and base materials, has been found in Egypt as part of their buildings; the features and limbs are well defined, and although the general arrangement is somewhat eonventional, still great Nature is pereeptible in their details, and a noble expression in the features.

On Colossal Statues.

Another remarkable feature of architectural deeoration, and without whieh it may be truly said that no entrance to

any important Egyptian edifice is complete, is the colossal statues, which were placed in front of the propylon of the greater Egyptian buildings. These colossi are either sitting or standing. In the former case, they represent certain of their gods, in the latter, persons or deities of less consequence. The two largest and most complete are those among the ruins of Thebes, which rise from the sandy desert waste as two enormous and gigantic masses, and are seen at a distance of five leagues. The figures are represented as seated with their arms resting as usual on their thighs. Hamilton, in his Egyptiaca, and other travellers, consider these statues 50 feet high. But Champollion Figeac states them at 60 feet. They are each formed of a single block of Breccia from the quarries of the upper Thebaid, and placed upon immense plinths of the same material. Each represents a Pharaoh seated in an attitude of repose. Denon thought them to be two females, Egyptian princesses. The upper part of one of the statues was destroyed in ancient times, either by an earthquake or the fury of conquerors, but has been repaired in later times of the Egyptian empire with courses of stone hewn so as to complete the figure, with great skill; if with no other intent or meaning — a smaller figure of a female is placed on each side of the figures, and attached to the chairs. They measure 15 feet high, and appear to represent Egyptian queens, one the mother of the king Tman-Hem-Va; the other the wife Taia of the same Pharaoh. To give you an idea of the unmeaning style of the hieroglyphic inscriptions placed upon statues and parts of Egyptian buildings, I will recite one of the enormous quantities of sculptured sentences, with which these chairs of their statues are covered. It is on the back — "Arœris the Powerful—The Moderator of Moderators—The Sun King—The Lord of Truth—Son of the

Sun — Lord of Diadems, Amenothph — Moderator of the Pure Region — Beloved of Amon-Ra — Resplendent Horus — He who has extended the dwelling for ever, has ereeted these eonstructions in honour of his father Ammon. He has dedieated to him this eonstruction of hard stone."

This inscription seems to indicate the titles and names of the third Amenophis of the eighteenth dynasty, who filled the throne of the Pharaohs about 1680 B. C. I have notieed that the statue is said by Hamilton to be about 50 feet high. The leg and foot of the northernmost is 18 feet 5 inehes. The length of the little finger is 4 feet 5 inehes. The plinth 6 feet high, 18 feet × 14 feet.

When the traveller looks on these statues, and easts his eyes around, and sees no propylon — no groups of columns to indieate that a building ever was near — he is led to think that they were independent of every sueh aeeompaniment. But modern researehes have diseovered, buried in the heaps of sand behind the statues, fragments of shafts and capitals of eolumns, belonging to some enormous edifices, onee thought as durable as the earth itself, but the barest traces of whieh now exist.

There are deposited in the British Museum many fragments of colossal figures. There is an arm 10 feet long, belonging to the statue, the head of whieh was brought over by Belzoni.

Obelisks.

Pliny says, that the first Egyptian king who erected an obelisk was Mitres, who held his court at Heliopolis, the City of the Sun, the deity to whom they were said to have been dedieated. Many others were raised by different monarehs; and "Ramises" made one 99 feet in height, on whieh he employed 20,000 workmen. And fearing lest the engineer should not take suffieient eare to proportion the power of the

machinery to the weight he had to use, he ordered his own son to be bound to the apex, more effectually to guarantee the safety of the monument.

Obelisks are the most simple monuments of Egyptian Architecture, and they must be considered as the most interesting that antiquity has transmitted to us, whether for the perfection of their execution, or for the material which has rendered them so enduring, but above all, are they remarkable for their prodigious mass and high antiquity—imposing testimonials of the glory and power of the Pharaohs, who erected them. These monuments reveal to us the arts and civilization of Egypt, at an epoch when the people, scattered by chance over the face of the world, were plunged in darkness and barbarity. The most ancient of the most venerated of books, the Pentateuch of Moses, was not then written—Abraham was unborn—but even then the inhabitant of Heliopolis adored his gods in the Temple of the Sun, and read upon the obelisk, still in its place, the name of Arœris, and that of the king who erected it. At that time reigned Osortasem, a powerful Pharaoh, whom fifteen royal dynasties had preceded, and who was to be followed by fifteen more, when Alexander the Great came to consult the oracle of Ammon, and to found at Alexandria a new capital to the old empire.

The origin of obelisks is still unknown; but they are supposed to have been principally dedicated to the Sun, Arœris, of whom the hawk was a symbol, on account of the elevation to which this bird extended his flight, and of the faculty which the ancients considered it to have of looking at the sun with a steady gaze. Pliny says, that the Egyptian term for an obelisk conveyed the idea of a sun's rays, which its form was supposed to symbolize. The term Obelisk is derived from the Greek term ὀβελος, which meant a spit,

a term which the witty Greeks gave them, with the view (like all wits in such cases) to cover with an air of ridicule what they could not lead one to condemn by fair argument.

The obelisks were generally of granite, at least the largest ones extracted from the quarries of Syene, and were of one block; thence called "*monoliths.*" They were quadrangular prisms, which diminished upwards, till they came rapidly to a point, called a pyramidion. They were placed on a cubical block or die, a little larger than the square of the shaft, which sometimes also had steps under it. The die was sometimes engraved with hieroglyphics, and some have Greek inscriptions carved on them. Not much attention was paid to the form of the die, which was sometimes irregular in shape, but it was generally narrower at top than at bottom. The surface of the shaft was generally covered with hieroglyphics, variously arranged; at one time distributed in one vertical line, at others in two or three columns; sometimes they were left quite plain, but they were then unfinished. These hieroglyphics generally consist of the royal titles, names, and surnames of the princes by whom they were erected—the names being contained within what is called a cartouche.

The two obelisks before the temple of Luxor, one of which has been removed to Paris, were not of the same dimension, the one being about 86 feet high to the top of the pyramidion, and at the base about 9 feet square. The other, now at Paris, was 7 feet 10 inches less in height, and at the base 8 feet 2 inches. It is supposed, that the difference in the height of these two pillars, intended to correspond the one with the other, arose from the difficulty of executing two of exactly the same size, without sacrificing a considerable portion of the height of one. In order to render the difference less apparent, the architect

had placed them on dies or pedestals of different heights, so that the base of the shorter one was raised above that of the other, half the difference of the height; and it was placed a little in advance of the other, to assist the illusion, and to augment the apparent scale of the less obelisk, by bringing it nearer the eye of the spectator.

Pyramidions — The summit of the Parisian obelisk was irregular in shape, and left quite rough. There was at bottom a channel and fillet, then a surface setting back, and the granite presenting an uneven surface. It was in the same state previous to its being lowered by the French. There must have been something to cover this unsightly appearance. Mons. Hittorff is led to conclude, that the French obelisk had originally a bronze capping gilt, which hid the rough misshapen pyramidion.

An Egyptian Temple.

We have now considered three of the principal accompaniments of an Egyptian Temple, the sphinxes, colossal figures, and obelisks, and their relative situations outside the sacred enclosure. We shall now proceed to go through the other details in their general arrangement and proportions.

Propylon — The propylon is the huge gateway, which encloses the end of the precinct. Unlike the propylon of Greek Architecture, which is a central feature of minor importance, and occupying only a small portion of the front, the Egyptian propylon extends the whole length of the front. At Karnak, one of these masses is 350 feet wide, the height 200 feet, consequently nearly half the width. It may be considered to be composed of two distinct pyramidal masses united by a central gate.

There are sinkings in the face of the propyla to receive the masts, which were put up on the festive days. These masts were painted, and had hieroglyphics on the face, and there were flags at top; these were attached at the upper parts by blocks of wood let into the mass of construction, for which holes were purposely left. The whole surface of these pyramidal masses were covered by sculptured pictures.

The portal being passed, brings us into the first court, surrounded by a colonnade, sometimes with a single row of columns, sometimes with a double row, at others with columns on two of the sides. In many temples there were several propyla erected by successive kings, who enlarged the sacred precinct by the continued addition of several precincts, each with its propylon. This second propylon brings us to a very interesting portion. It is the Great Hall.

Great Hall.—This hall at Karnak is 345 feet wide by 155 deep, the larger columns are 10 feet 8 inches in diameter, and 66 feet high; the less 8 feet 6½ inches in diameter, and 42 feet high. This size must have been imposing, and the scene most splendid, from the vast quantity of painting on the walls, columns, and ceilings.

Capitals of Columns.—As regards capitals, I should divide them into the bud shape and expanded form; for, if we look at the capital from Luksor, we shall see on the side, somewhat large, the drawing of the ornaments on the vase of the capital, consisting of buds and expanded leaves; and the shapes of the capitals correspond with these forms, showing evidently that the Egyptians adopted flowers as the first types of the capitals of their columns, and that

the varieties which we find correspond with those in nature. In fact, some shafts of columns represent a bundle of stems tied together, as at Beni Hassan; and the bottom expands instead of contracting, in imitation of the butt end of the palm tree next the root. Sometimes the overhanging edge of the top of the capital is one continuous line, as in the capital from Luksor; at others, it is broken into divisions, as in the one from Philœ, forming curved forms, eight in the circumference, sometimes equal, at others varying in size. The varieties in the mode of ornamenting the hollow of the vase of the capital are innumerable, and it must be owned, that the Egyptians have evinced more design and imagination therein than the Greeks or Romans.

The next court contains porticos on its three sides, and on the fourth are the pronaos or porch, which consists generally of a more magnificent and larger order than those preceding in the Courts or Hall. But at Luksor the columns are the same in size as those of the court, which here, as it were, form part of the pronaos or porch of the Hypœthral or open form, presenting the entrance to the temple more studded with columns, and consequently with a deeper gloom and solemn aspect.

Frontispiece — In different temples the frontispiece is variously arranged. At Luksor the columns are free and disengaged, somewhat like the Greek and Roman temples in Antis. But more frequently the columns are closed in the lower part by an intercolumnar parapet or enclosure. The object of this does not seem very apparent. Was it to exclude from obtrusive gaze the hallowed solemnities of the inner penetralia? Was it to afford a shade, within which the worshippers might perform their rites defended

from the burning sun? These are questions in the solution of which we have no authority to guide us. Certainly these intermediate parapets detract from the dignity of the columns, which they seem to enclose.

Denderah — Let us contemplate the elevation of the temple at Denderah. There are six columns and the angular piers. The whole face of the temple inclines backward, to give the appearance of greater strength and durability to the mass. The piers are wider at the bottom than at top, the inner line being perpendicular, the outer one following the inclination of the body of the building. There is the torus at the angle, running up to under the cornice, then pursuing a horizontal direction. Above is the cornice, with its hieroglyphics, and over the centre the winged globe and serpents. The central intercolumniation is wider than the other, being $2\frac{1}{2}$ diameters, the others less than $1\frac{1}{4}$. The intercolumnar enclosure exists here $2\frac{2}{3}$ diameters high, the centre one nearly 4. A remarkable feature in the central enclosure is, that the cornice does not run through, so that the middle aperture is left quite free. Why was this? Did it not always remain so, or was it closed by gates or a curtain?

The side enclosures have a regular cornice, in the centre of which is a winged globe and serpents as usual, and above, a row of crowned serpents. The centre is occupied by a picture with three figures. The columns are straight from the plinth to the cap, with a regular diminution; but the caps consist of four human heads, one on each of the four sides of the columns, with full tresses hanging down on either side of the face, supposed to represent Isis. Above is a large die of larger proportions than usual, representing an edifice in the ordinary pyramidal form, with

a picture of two figures of a god and worshipper. There are four rows of columns, making twenty-four in all to form the porch.

Porch — Let us enter the porch, and here we find the whole of the surfaces covered with paintings. The ceiling has an azure ground with a series of sacred hawks and cartouches, and gilt stars on a blue ground. The front wall presents the same elevation as the front of the temple itself, with its circumscribing torus and cornice, and the door is also decorated with the architraves, cornice, and the usual winged globe.

We then come to a variety of apartments or chapels, which it is difficult to appropriate satisfactorily, for we hardly know where the devotional parts exist, and where the residences of the priests begin: but it seems that probably the statue of the god was in the inmost sanctuary, σηκος; or perhaps the sacred animal itself, worshipped by this people, was kept there, of granite. Light was admitted through small apertures. The whole precinct was surrounded by walls. Probably the larger temples contained tanks, promenades, and avenues of trees. There was a continued rise from the entrance to the porch.

We commenced the consideration of Egyptian Architecture with the contemplation of the Rock Tombs near Thebes, as affording us a key to the character and impressions prevalent throughout the sacred edifices of that people. We have now to complete our survey of their monumental art by a brief description of the Pyramids of Ghizeh. We have hitherto followed, in a great degree, the chronological order of our subject; but we have now to revert to the remotest periods of Egyptian art and history. We have to go back almost,

as it were, into the womb of time, before the death of Noah, the patriarch of the Flood.

The Pyramids of Ghizeh are situate on a platform, on the slope of the mountains, in the neighbourhood of the ancient Memphis, forming apparently a species of Necropolis to that city. In the immediate vicinity, but on the opposite bank of the Nile, are Aboukir, Saccara, Achour, within a space of about three leagues, all abounding in Pyramids, and at a few miles' distance only from Cairo.

The three large Pyramids of Ghizeh were erected by the three first kings of the fourth dynasty, and were used as their tombs. Around these immense monuments were other Pyramids of smaller dimensions, and some tombs constructed of large blocks of stone, which served as places of sepulture for the branches of the three ancient kings. There is a short distance between them and the Pyramids of Sakkarah, occupied by the desert. At Sakkarah is the ancient cemetery of Memphis, called the Plain of the Mummies, scattered over with Pyramids and tombs. Its aspect is at this time gloomy and melancholy. The rapacity of excavators has spread desolation over that whole area. The tombs, originally decorated with sculpture, are laid waste; the ground is covered with hillocks of sand, and the surface is scattered over with human bones, blanched by time, the remains of the earliest periods. At Ghizeh are to be found the Pyramids most noted for their enormous magnitude. In order to appreciate these impressive works, they should be studied on the spot. They appear to diminish in height as the traveller draws near them, and it is only when his finger touches the blocks of stone of which these stupendous masses are composed, that any correct idea can be formed of their immensity.

These three large Pyramids rest on their rocky base of the platform, at an elevation of nearly 100 feet above the

level of the waters of the Nile. They are placed at irregular distances from each other; and this remarkable fact has been discovered in regard to the great Pyramid, that its diagonal lines exactly correspond with the cardinal points. It is with the greatest difficulty, that at the present time, we can trace so extended a meridian without deviation. Another important fact, in regard to the physical history of the globe, is connected with this astronomical precision of the ancient Egyptians. It is, that during 4000 years the position of the terrestrial axis has not varied in any sensible degree — and the great Pyramid is the only object on the earth, which, by its antiquity, can furnish a similar observation.

On the south side of the great Pyramid are the remains of three smaller Pyramids, and on the west side of the smallest of the three great ones are three other small Pyramids, supposed to have been built for the wives of the respective kings, to whose larger constructions they are attached.

The faces of the Pyramids present a receding series of above 200 steps of colossal blocks and rough construction; but the summit of the second Pyramid, instead of steps, offers to view a continuous sloping revetment. This circumstance, and the discovery of wrought blocks of a compact limestone, called Turnestone, with a sloping polished face, prove, that the whole surface of each Pyramid had a smooth inclined casing.

The entrances to the Pyramids all occur on the north-east side, and generally there were two to each; one near the base, another at 45 feet elevation above. Here the arrangement of the blocks presents an ingenious and peculiar construction. The aperture of admission is about 4 feet square, so that one is obliged to stoop in order to enter. There is a huge block or lintel over the opening, and another small one

above. Then there are four inclined blocks of granite, which discharge the weight from above the opening, and secure the solidity of the mass.

The gallery then follows an inclined direction downwards towards the centre of the Pyramid, and is 75 feet in length. It ends at another one 3 feet 5 inches in height and width, in an ascending direction, 200 feet in length. A large block of granite, forming a species of portcullis, which can only be moved by being raised up a narrow groove left in the construction, divides the two galleries. At the extremity of the second gallery is a landing, and to the right an entrance to a deep shaft cut in the rock, 24 × 22 inches. Then begins a horizontal gallery, 117 feet in extent. It conducts you to a chamber called the Chamber of the Queen, which is 17 feet 10 inches long × 16 feet 1 inch wide. It is empty.

On returning to the entrance of the horizontal passage, you go into a new gallery, 125 feet long, 6½ feet wide, and 25 feet high. The roof or ceiling of this gallery has the appearance of an arch, as it consists of eight blocks of stone, each one of which overhangs the one below it, and thus discharges the weight of the mass above. On each side of the gallery is a bench 19 inches wide and 21 inches high, the purpose of which has not yet been ascertained. At the extremity of this gallery is a landing, beyond which is a vestibule leading to a passage 3 feet 3 inches wide by 3 feet 5 inches high, and 7 feet 10 inches long. Here we approach the most solemn and important portion of this wondrous monument. We are about to enter the chamber in which lay, for many centuries, the remains of a sovereign coeval with the patriarchs of God's people, the monarch of many nations, here deposited in all the splendour of a pomp-loving people, covered by a mass that has defied destruction, and as it

were, impenetrably hid from the curiosity of future ages, and thought to be secure against the despoiling hand of the sacrilegious conqueror or the curious despoiler.

The King's Chamber is 34 feet long, 17 feet wide, and 19 feet high. At the western end may be seen the tenantless granite sarcophagus, 7 feet 1 inch long, by 3 feet 1 inch wide, by 3 feet 6 inches high, placed in a direction due north and south, but without its lid, which has not been seen. Small air shafts ventilate this chamber, having an inclined direction upwards, and issuing about two-thirds up the Pyramid. The ingenuity of the construction is again evident in the arrangement of the blocks which form the ceiling. The chamber is covered by a series of slabs of granite, a hollow space is then left, and another series of like slabs, in four heights, gradually diminishing at the top ; above are inclined blocks, acting as discharging slabs, and relieving the weight from its pressure over the chamber, which is almost immediately under the apex of the Pyramid.

Let us then sum up some of the many curious facts connected with these stupendous erections —

1. First of all, their perfect orientation in regard to the points of the compass.

2. Then the immense mass of construction, apparently for the mere purpose of a tomb.

3. Their enormous cost ; for, taking the lowest possible calculation, I conceive, that upon the great Pyramid must have been spent at least four millions and a half of our money.

4. The very small size of the galleries, which rarely exceeded 3 feet 5 inches in height or width, so that the sarcophagus in the royal sepulchral chamber must have been deposited there before it was closed in ; and probably the

galleries were of such small dimensions, as to prevent the possibility of removing the sacred deposit.

5. The ingenious but ineffectual manner of baffling a forcible entrance into the body of the Pyramid by the granite portcullis, which were of one slab, 9 inches thick, and which, closing the passage, seemed to forbid farther progress, on account of their enormous weight, and the confined room left for the requisite machinery to force the slabs up into their groove, and thus leave the passage free.

Again, 6. The total absence of any engraved inscriptions or sculptures, whether on the walls or ceilings, or on the sarcophagus — an omission the more striking, since the ancient tombs of Thebes, and all the sarcophagi, even those of secondary importance, were absolutely covered with hieroglyphics.

Suggested Motive of Erection — If our contemplation of the object and uses of these gigantic masses stopped here, we might ascribe their erection to a vain and extravagant passion for immortal fame, and the futile idea of securing an impenetrable deposit for the royal remains — an idle thought, dissipated by the rude skill of Arab Caliphs, who have opened and plundered all these Pyramids. But let us not disregard the testimony borne by all antiquity to the proverbial and practical wisdom of this people, and may we not imagine a more benevolent and deep thinking purpose in these constructions? The Egyptians were essentially a commercial people, and vast wealth was derived from their relations with foreign nations, as being a corn-growing country. There was consequently a prodigious agricultural population also, whose labours were confined to a few weeks in the year, and who, during the interval, were probably without other employment and means of subsis-

tence, and possibly would starve were they not engaged on public works. May we not then imagine, that these rude masses might have been conceived, among other works, and executed, chiefly for the purpose of providing labour for the lower orders during the idle part of the year, and thus saving them from want and starvation? The general mass of the construction was of the simplest sort, and thousands of ordinary hands would be employed in excavating and removing the rough blocks of masonry, in levelling the rock, excavating or raising the causeways, and other labours; which accomplished a double purpose — of raising a tomb to the monarch, and giving employment and food to millions of his subjects — a glorious and a benevolent end, more deeply impressed upon my mind by the calamitous events of the famine in Ireland and the Highlands of Scotland, which occurred not many years ago.

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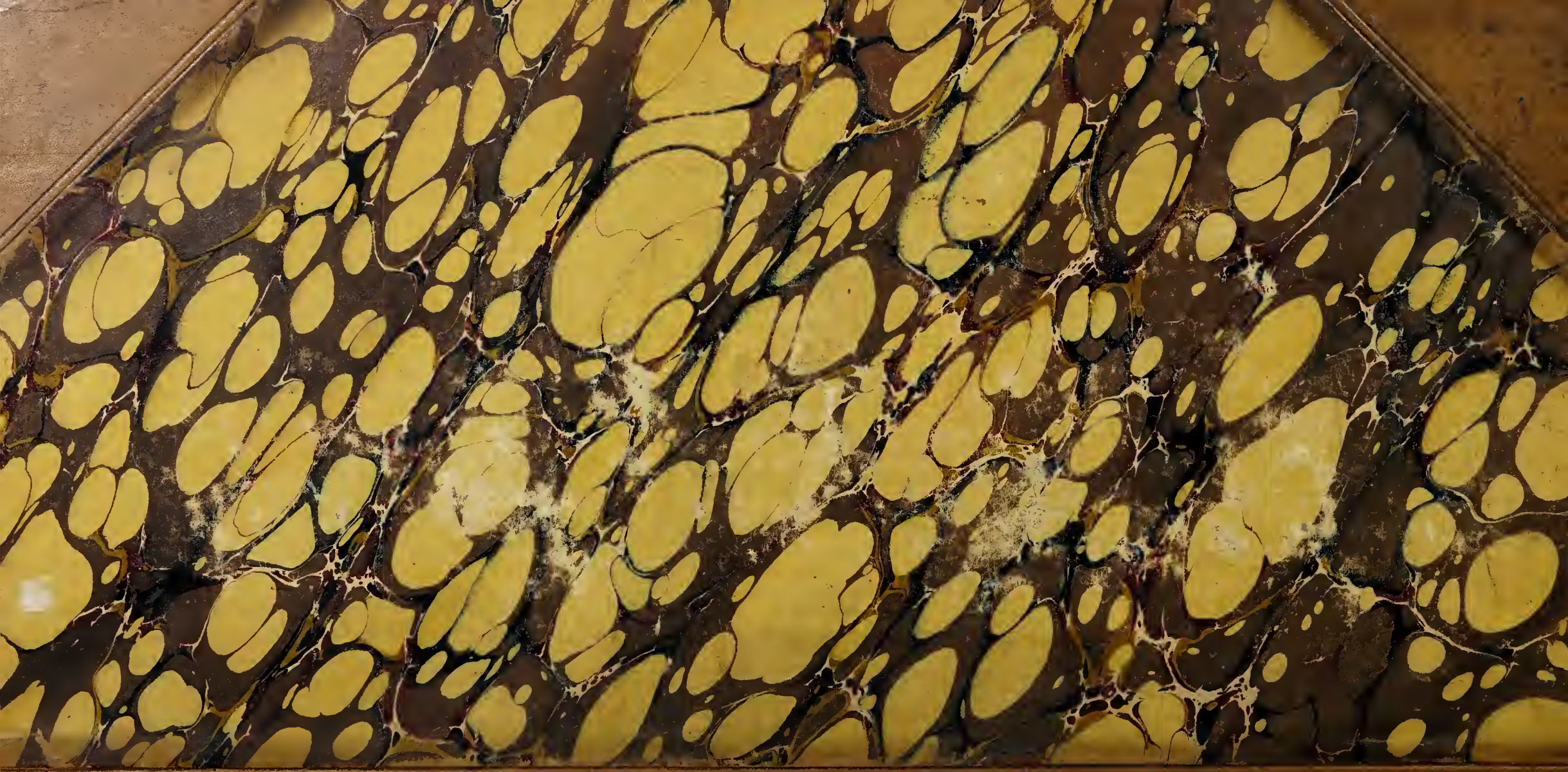
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